CANADA
DEPARTMENT OF MINES
GEOLOGICAL SURVEY BRANCH
HON. W. TEMPLEMAN, MINISTER; A. P. LOW, DEPUTY MINISTER;
R. W. BROCK, ACTING DIRECTOR.

REPORT

ON

TERTIARY PLANTS OF BRITISH COLUMBIA

COLLECTED BY

LAWRENCE M. LAMBE IN 1906

TOGETHER WITH A

DISCUSSION OF PREVIOUSLY RECORDED TERTIARY FLORAS

BY

D. P. PENHALLOW, D. Sc., F.G.S.A.

OTTAWA
GOVERNMENT PRINTING BUREAU
1908

No. 1013.

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MONTREAL, February 3rd, 1908.

R. W. BROCK, Esq ,
Acting Director,
Geological Survey of Canada.

SIR,—I have the honour to transmit, herewith, a Report on the Tertiary Floras of British Columbia and other portions of Western Canada, based upon material collected by Mr. L. M. Lambe in 1906.

I have the honour to be,
Your obedient servant,

D. P. PENHALLOW.

REPORT

ON

TERTIARY PLANTS OF BRITISH COLUMBIA

COLLECTED BY MR. LAWRENCE M. LAMBE IN 1906

TOGETHER WITH A DISCUSSION OF PREVIOUSLY RECORDED TERTIARY FLORAS

BY D. P. PENHALLOW, D. Sc.

INTRODUCTION

The material which forms the basis of the present monograph was obtained by Mr. L. M. Lambe of the Geological Survey of Canada in the summer of 1906, and was transmitted to me for determination in the following autumn. The collection embraces a very large number of specimens, some of them new to their particular localities, and some of them representative of hitherto undescribed species. The importance and extent of this collection present a most favourable opportunity for bringing together the results of previous studies; of establishing on a more complete basis the relations of the various Tertiary floras of Canada and correlating them with similar floras within the boundary of the United States; and through a comprehensive survey of the entire Tertiary floras of Canada, of answering some of the questions relative to the ages of the Tertiary deposits of the western provinces. The Tertiary deposits of western Canada are spread irregularly over a wide extent of territory in British Columbia, Alberta and Saskatchewan, extending thence into the area of the western United States, but with important outliers to the northward and westward in the Queen Charlotte islands, northern British Columbia, Yukon territory and the region of the Mackenzie River basin in the North-west Territory. Many of these outlying areas are very small, and all of them are widely separated. Although much has been accomplished during the last sixty years, with respect to determining the age of these beds, it is still an open question as to the precise horizons within which they fall, and the number of successive stages represented in the Tertiary as a whole. The results obtained from the present studies appear to confirm in important ways conclusions already reached by Sir William Dawson, Dr. G. M. Dawson, Cope, Newberry and others, and the hope is indulged that, even if they add nothing new, they may serve to more completely clear up some of the questions about which there is at present reasonable doubt.

It will be useful to indicate at the outset the extent of the collections of Tertiary plants so far made and described, and in the following list these are given in connexion with the authorities by whom they were determined, as also the place of publication. From this it will be seen that some of the more recent collections have been reported upon but not published, and they are therefore included in the present monograph as the place of first publication.

1. HEER, OSWALD.—On a Collection of Plants from the Mackenzie River, made by Sir John Richardson's Searching Expedition in 1851.
Flor. Foss. Arct., I, 1868; VI, 1880.

2. DAWSON, SIR J. W.—Note on Fossil Plants collected by Dr. A. Selwyn, from the Edmonton Coal Beds in 1874.
Geol. Surv. Can., 1873–74, p. 51

3. DAWSON, SIR J. W.—A Collection of Plants from the Region of the International Boundary, collected by Dr. G. M. Dawson in 1873–74.
Brit. N. Amer. Bound. Comm., 1875, App. 328–331.

4. DAWSON, SIR J. W.—A Collection of Plants from the Mouth of the Quesnel River, British Columbia.
Geol. Surv. Can., 1871–72, p. 59; 1875–76, p. 259–260.
Trans. R.S.C., I, 1882–83, iv, 33.

5. DAWSON, SIR J. W.—A Collection of Plants from the Blackwater River of British Columbia.
Geol. Surv. Can., 1875–76, p. 259–260.
Trans. R.S.C., I, 1882–83, iv, 33.

6. DAWSON, SIR J. W.—A Collection of Plants from Coal Brook, Indian Reserve, North Thompson River, British Columbia.
Geol. Surv. Can, 1877–78, 186 B.
Trans. R.S.C., I, 1882–83, iv, 34.

7. DAWSON, SIR J. W.—A Collection of Plants from Vermilion Cliff, Tulameen River, British Columbia.
Geol. Surv. Can., 1877–78, 186 B.

8. DAWSON, SIR J. W.—A Collection of Plants from Nine-mile Creek, Whipsaw River, British Columbia.
Geol. Surv. Can., 1877-78, 186 B.

9. DAWSON, SIR J. W.—A Collection of Plants from the Lignite Tertiary of Roche Percee, Souris River, Saskatchewan.
Geol. Surv. Can., 1879-80, 51-55 A.

10. DAWSON, SIR J. W.—Tertiary Plants of British Columbia and the North-west Territories.
Trans. R.S.C., 1882, I, iv, p. 15.

11. DAWSON, SIR J. W.—On the Mesozoic Floras of the Rocky Mountain Region. (Contains a short account of Tertiary Plants).
Trans. R.S.C., III, 1885, iv, 15-18,

12. DAWSON, SIR J. W.—Fossil Plants from the Laramie Formation of Canada.
Trans. R.S.C., IV, 1886, iv, 17-34.

13. DAWSON, Sir J. W.—Report on a Collection of Plants from the Red Deer River, British Columbia.
Geol. Surv. Can., 1887, 137 E.

14. DAWSON, SIR J. W.—Fossil Woods from the Laramie of Canada.
Trans. R. S. C., V. 1887, iv. 31-37.

15. DAWSON, SIR J. W.—Fossil Plants collected by R. G. McConnell on the Mackenzie River, North-west Territory.
Trans. R.S.C., VII, 1889, iv, 69-74.

16. DAWSON, SIR J. W.—Fossil Plants collected by T. C. Weston on the Bow River, British Columbia.
Trans. R.S.C., VII, 1889, iv, 69-71.
Geol. Surv. Can., N. Ser., IV, 1888-89, 96 D.

17. DAWSON, SIR J. W.—Fossil Plants from the Similkameen Valley and other places in the Southern Interior of British Columbia.
Trans. R.S.C., I, 1882-83, iv, 34; VIII, 1890, iv, 75-91.

18. DAWSON, SIR J. W.—A Collection of Plants from the Finlay and Omineca Rivers, British Columbia.
Geol. Surv. Can., VII, 1894, 36 C.

19. DAWSON, SIR J. W.—Collections of Plants from the Vicinity of Vancouver, British Columbia.
Trans. R.S.C., N.S., I, 1895, iv, 137-162.

20. PENHALLOW, D. P.—Plants from the Red Deer River, at the mouth of the Blindman River, Alberta, collected by L. M. Lambe in 1897.
Included in the present paper.

21. PENHALLOW, D. P.—Plants from the Red Deer River, Alberta, in the collections of the Peter Redpath Museum, McGill University.
Trans. R.S.C., VIII, 1902, iv, 46.

22. PENHALLOW, D. P.—Plants from the Tertiary of the Horsefly River, British Columbia, in the collections of the Peter Redpath Museum, McGill University.
Trans. R.S.C., VIII, 1902, iv, 68.

23. PENHALLOW, D. P.—Notes on Tertiary Plants from the Laramie of Porcupine Creek and Great Valley, Saskatchewan, in the collections of the Peter Redpath Museum, McGill University.
Trans. R.S.C., IX, 1903, iv, 33.

24. PENHALLOW, D. P.—Plants from the Kettle River, British Columbia, collected by Dr. R. A. Daly, 1903.
Trans. R.S.C., XIII, 1907, iv.

25. PENHALLOW, D. P.—Notes on Tertiary Plants from the Laramie of Alberta and Saskatchewan, in the collections of the Peter Redpath Museum, McGill University.
Trans. R.S.C., X, 1904, iv, 57.

26. PENHALLOW, D. P.—Plants from Coal Gully, near Coutlee, British Columbia, collected by Dr. Ells and R. R. A. Johnston, 1904.
Included in the present paper.

27. PENHALLOW, D. P.—Plants from the Diamond Vale Coal Company, Quilchena, British Columbia, collected by Dr. Ells and R. R. A. Johnston, 1904.
Included in the present paper.

28 Penhallow, D. P.—Plants from the Region of the International Boundary in British Columbia, collected by Dr. R. A. Daly; 1905.
Trans. R.S.C., XIII, 1907, iv.

29. Penhallow, D. P.—Plants from the Tulameen River, British Columbia, collected by L. M. Lambe, 1 06.
Present paper.

30. Penhallow, D. P.—Plants from the Tranquille River, British Columbia, collected by L. M. Lambe, 1906.
Present paper.

31. Penhallow, D. P.—Plants from Coal Gully, near Coutlee, British Columbia, collected by L. M. Lambe, 1906.
Present paper.

32. Penhallow, D. P.—Plants from Quilchena, British Columbia, collected by L. M. Lambe, 1906. Present paper.

33. Penhallow, D. P.—Plants from the Similkameen Valley, British Columbia, collected by L. M. Lambe, 1906. Present paper.

The following statement of special localities from which plants have been derived is presented with a view to exhibiting, as nearly as possible, their relations with respect to horizon and geographical position.

1. The Souris river.
   Roche Percee, Saskatchewan.
2. Porcupine creek and Great valley, Saskatchewan.
3. Calgary, Alberta.
4. Cochrane, Alberta.
5. Red Deer river, Alberta.
6. Edmonton, Alberta.
7. Great Bear river, Mackenzie basin, North-west Territories.
8. Similkameen valley, British Columbia, including
   (*a*) The Similkameen river embracing all localities not otherwise designated.
   (*b*) Tulameen or North Similkameen river.
      (1) Vermilion cliff.
   (*c*) Similkameen river.*
      (1) Whipsaw creek.
      (2) Nine-mile creek, on the Whipsaw, 8 miles from the mouth of the Tulameen.
9. Kettle river, Southern British Columbia.
10. Nicola basin, British Columbia.
   (*a*) Coal gully.
   (*b*) Quilchena.
   (*c*) Coldwater river.
   (*d*) Stump lake.

*Until lately known as the South Similkameen river.

11. Horsefly river, British Columbia.
12. Quesnel river, British Columbia.
13. Cariboo gold mine, British Columbia.
14. Blackwater river, British Columbia.
15. Tranquille river, British Columbia.
16. Kamloops, British Columbia.
17. Finlay river, British Columbia.
18. Omineca river, British Columbia.
19. Coal brook, Indian Reserve, North Thompson river, North-west Territories.
20. Burrard inlet, British Columbia.

DESCRIPTION OF LOCALITIES AND THEIR FLORAS.

SOURIS RIVER.

The locality referred to in this paper, and by Sir William Dawson in his papers dealing with descriptions of plants, as the Souris river, may be more specifically designated as Roche Percee, inasmuch as that is the place from which the few specimens of that region were chiefly obtained.

Proceeding westward from the Pembina mountains along the International Boundary from about longitude 102° to 106° 30′ west, there are three important regions within which the Lignite Tertiary beds present exposures. The first of these is the locality just indicated. As the Souris river descends from the northwest along the foot of the Dirt hills and the Missouri côteau, it reaches the Boundary Line at about longitude 103° 30′, thence turns north and east, following the line to nearly longitude 102° when it once more turns south and crosses into the United States. In its easterly course it cuts through the Tertiary formation and exposes its structure to a depth of fifty feet or more.

The rocks of the Lignite Tertiary are first seen about four miles east of Short creek and about six miles north of the Boundary at the place known as Roche Percee The formation is the same as for other portions of the Lignite Tertiary along the International Boundary, and its description may therefore be included in that for the Porcupine creek and Great valley.

The flora derived from Roche Percee is very meagre, but so far as it is known, it seems to confirm the general conclusions at present accepted relative to the extension of the Lignite Tertiary area and its relation to the floras of Porcupine creek, Calgary and the Mackenzie River basin. This record as given by Sir William Dawson (**13**) embraces the following species :—

Platanus nobilis, Newb.
Quercus sp.
Sassafras selwyni, Dn.
Taxites olriki, Heer.
Taxodium occidentale, Newb.

From the point where the lignite beds are first seen, exposures occur at frequent intervals in the banks of the Souris river, westward, to a distance of about twelve miles by the Line, and considerably more by the river.

Farther to the west, the Tertiary formation immediately south of the Line has been eroded to a depth of several hundred feet, and this has been carried out to such an extent that isolated buttes have been left in otherwise broad plains. The whole area of about 8,000 square miles has been deeply scored by numerous intersecting valleys which make it an almost impassable territory. These "Bad Lands" of the upper Missouri have been pushed northward across the International Boundary where they meet the more undisturbed and more elevated Tertiary plateau or Missouri côteau. The drainage from this plateau southward has resulted in the cutting of several great gorges or valleys as the streams descend from the côteau to the level of the Bad Lands, and in them important exposures of the formation are to be met with. The most notable of these gorges are the Great valley at about longitude 105°, and Porcupine creek at about 105° 45′ and thirty-five miles west of Pyramid creek which may be considered in connexion with Great valley. These three regions—Souris river, Great valley and Porcupine creek, although usually described separately, may be treated floristically as one, for the reason that they represent exposures of the same formation, and the floras are the same.

GREAT VALLEY.

The most complete account of the Great valley has been given by G. M. Dawson (**6**,92), who has shown it to be the most eastern great channel of erosion which crosses the International Boundary southward, towards the Missouri, and in it the beds of Lignite Tertiary are exhibited on a grand scale. They are exposed at an elevation of about seven hundred feet above those of the Souris river at Wood End, and about six hundred feet above those of the northern locality at Traders Road, but their exact relation to the latter has not been determined.

The complete section of the beds has a thickness of 210 feet, and the lowest of these contain the plant remains. They consist of curiously banded clays and shales which have a purple tint when viewed from a distance. In the upper portions of the section somewhat abundant remains of mollusca occur but only those of fresh water origin.

Many of the crumbling hill-tops of the valley have a brick red colour resembling that seen in parts of the Souris valley, and due, as there, to the combustion *in situ* of the deposits of lignite. The slag or clinker produced by this action is also found, though not observed in place.

PORCUPINE CREEK.

Porcupine creek is the third of the great Tertiary exposures along the International Boundary. In it and tributary valleys many partial sections occur (**6**, 97), and lignite is seen in three places near the Boundary Line, just above the level of the water in each case. The beds which overlie the lignite consist of yellowish and grey sands and clays, well stratified, and closely resembling those forming the upper part of the section of Great valley.

In a section thirty-one feet thick, the lignite bed lies within one to two feet of the bottom and has a thickness of three to four feet. Above this, for twenty-five feet, there are alternating strata of grey clay and sand, ranging from three inches to nine feet, which contain plant remains in various states of preservation.

In a tributary valley entering Porcupine creek from the west, a section forty feet and three inches in thickness contains a lignite bed nine inches thick at a depth of eleven and one-half feet. At a depth of seventeen feet there is another lignite bed eighteen feet thick. This rests upon soft, grey sandstone, and like the bed above, is overlaid with banded yellow-grey and purple clays containing well preserved plant remains.

The flora of Great valley and Porcupine creek was first studied by Sir William Dawson in 1875 (**25**, 327–331). This list was extended and published in 1886 (**24**, 17–31) as the result of further collections. More recently Penhallow (**79**, 33–95, **73**, 60, 61) has revised the woods of these collections and determined doubtful species, and in the course of this revision it was found that some new species must be included. As now known upon the basis of these studies, the flora of this district is composed as follows:—

1. *Æsculus antiquas*, Dn.
2. *Carya antiquorum*, Newb.
3. *Carpolithes* sp.
4. *Castanea* sp. (*Quercus* of the report of 1879-80).
5. *Catalpa crassifolia*, Newb.
6. *Corylus americana*, Walt.
7. *macquarrii*, Heer.
8. *rostrata*, Ait.
9. *Cupressoxylon dawsoni*, Penh. Wood.
10. *Davallia tenuifolia*, Sw.
11. *Diospyros* sp.
12. *Equisetum* sp.
13. *Equisetum parlatorii*, (Heer) Knowlton.
14. *Gingko* sp. (Probably *G. adiantoides*).
15. *Glyptostrobus europæus*, (Brongn) Heer.
16. *Juglans cinerea ?* L.
17. *rhamnoides*, Lesq.
18. *rugosa*, Lesq.
19. *schimperi*, Lesq.
20. *Lemna scutata*, Dn.
21. *Onoclea sensibilis*, Newb.
22. *Paliurus colombi*, Heer.
23. *Phyllites* sp.
24. *caparinoides*, Newb.
25. *venosus*, Newb.
26. *Phragmites* sp.
27. *Platanus haydenii*, Newb.
28. *heterophyllus*, Newb.
29. *nobilis*, Newb.
30. *raynoldsii*, Newb.
31. *Populus acerifolia*, Newb.
32. *arctica*, Heer.
33. *genetrix*, Newb.
34. *richardsoni*, Heer.
35. *Pseudotsuga miocena*, Penh. Wood.
36. *Quercus* sp.
37. *Rhamnus* sp.
38. *concinnus*, Newb.

39. *Rhamnacinium porcupinianum* Penh. Wood.
40. *triseriatim*, Penh. Wood.
41. *Salix laramiana*, Dn.
42. *raeana*, Heer.
43. *Sapindus affinis*, Newb.
44. *Sassafras burpeana*, Dn.
45. *selwyni*, Dn.
46. *Scirpus* sp.
47. *Scirpus* sp.
48. *Sequoia burgessii*, Penh. Wood.
49. *langsdorfii*, (Brongn) Heer. Wood and leaves.
50. *nordenskioldii*, Heer.
51. *Symphorocarpophyllum* sp.
52. *albertum*, Dn.
53. *linnæforme*, Dn.
54. *Taxites olriki*, Heer.
55. *Taxodium distichum*, Rich. Wood. This is probably the wood of either *T. distinchum miocenum*, Heer, or *T. occidentale*, Newb.
56. *occidentale*, Newb.
57. *Thuya* sp. Wood. Probably the wood of the next.
58. *interrupta*, Newb.
59. *Trapa borealis*, Heer.
60. *microphylla*, Newb.
61. *Ulmus precursor*, Dn.
62. *Viburnum asperum*, Newb.
63. *calgarianum*, Dn.
64. *oxycoccoides*, Dn.
65. *lanceloatum*, Newb.
66. *pubescens*, Pursh.

One of the first accounts of the geology of the Tertiary of southern Saskatchewan and Alberta and its contained fossils was given by Dr. James Hector in 1861 (**31**,393,407-409), but the first complete knowledge of the region was derived from the work of Dr. G. M. Dawson in connexion with the British North American Boundary Commission in 1873-74 (**6**.) and of the Geological Survey of Canada in 1877–78 (**8**). Reviewing the data thus brought together, it is to be observed that the Lignite Tertiary extends from east to west, no less than two hundred and sixty miles. In the region of Roche Percee, the outcrops of lignite are firm and compact, and in many places it shows spots of amber. When exposed by river cutting, the beds present, at the margin, a large amount of clinker giving evidence of combustion of the lignite (**5**,164).

From the Souris river westward, the Lignite Tertiary nearly always occupies high ground and frequently forms a well developed plateau resting upon Cretaceous clays, and in the region of the Great valley and Pyramid creek the lignite beds are exposed at an elevation of about seven hundred feet greater than those last seen on the Souris river. Here, as at Porcupine creek, the Souris river and in the Bad Lands of the United States, the formation consists of beds of lignite interstratified with variously coloured clays and sands, some of which are remarkable for the perfect preservation of numerous plants. Porous material like scoriaceous lava, indurated clays and metamorphosed sandstones is frequently met with, either in place or widely scattered over the surface of the valleys, and is to be recognized as resulting from

combustion of the lignite beds. By reason of the greater resistance which these altered beds offer to erosion, the exposures are greatly diversified and are productive of those remarkable features exhibited in the Roche Percee and in the characteristic aspects of the Bad Lands. The lignite beds may have a thickness of from a few inches to eighteen feet, and they are usually overlaid with a plant-bearing bed of clay.

Dr. Dawson points out that in their eastern extension the lignite deposits show no trace of marine or brackish water conditions, and whenever remains of molluscs are found, they are those of fresh water (**5**,152.) From Roche Percee westward to Wood mountain, the deposits are identical with the eastern fresh-water extension of the southern Lignite Tertiary or Fort Union beds (**6**,154.) But from Wood mountain westward the character of the formation changes, until in the region of the buttes the appearance is totally different. The introduction of the remains of reptiles adds a new feature, and in the Milk river fresh water forms are mixed with marine *Ostrea*. In the Sweet-grass hills, *Ostrea* shells are found in great abundance, together with molluscs identical with those of the Bitter Creek Coal series of Wyoming, and a *Dostia*, probably the same as those from Coalville, Utah. Although there is a reversion to fresh-water forms near the first and second branches of the Milk river, the general tendency is towards salt water conditions eastward—the former spread eastward in the lower layers as far as Roche Percee, while the latter spread westward in the upper beds, nearly to the base of the mountains.

Dr. Dawson closes his account with the conclusion that the Tertiary beds of the Forty-ninth parallel are identical with those of the Judith River formation, " the age of which has long been an unsettled question, and they have only lately been included by some geologists with the remainder of the Lignite Tertiary and called Cretaceous Dr. Hayden was only prevented from calling them Fort Union Tertiary by the occurrence of certain vertebrate remains, the meaning of which is now better understood" (**6**,157).

CALGARY AND COCHRANE, ALBERTA.

Cochrane, Alberta, lies on the western edge of the Laramie basin, about six hundred miles northwest of Roche Percee, while Calgary is about twenty-five miles to the southeast of the former. As the formation in these localities is the same as for the more southern portions of the basin, no further discussion is required in this connexion.

Very few plants have been collected from either of these places. Penhallow (**74**, 57) has recorded two species of wood from Cochrane, one of which is a species of *Thuya*, probably *T. interrupta*, which is found abundantly through the Tertiary of the western provinces. The other is a species of *Taxodium* which has been designated as *T. laramianum*, but it is quite probable that it may be the wood of *T. occidentale*, a species very common to the Lignite Tertiary.

From Calgary, Sir William Dawson has obtained nine species (**26**, 15-18) as follows :—

1. *Platanus nobilis*, Newb.
2. *raynoldsii*, Newb.
3. *Populus acerifolia*. Newb.
4. *cordifolia*, Newb.
5. *genetrix*, Newb.
6. *Sassafras burpeana*, Dn.

7. *Viburnum calgarianum*, Dn.
8. *oxycoccoides*, Dn.
9. *Gingko* sp. Probably *G. adiantoides.*

RED DEER RIVER, ALBERTA.

The Red Deer river lies on the eastern water-shed of the Rocky mountains, its course extending thence to the Great plains, crossing the entire width of the Laramie basin. The river enters this area on the west about thirty-six miles northwest of Cochrane, it then runs northeast sixty-five miles to Blackfolds, thence south and east to near long. 113° west, and finally southeast seventy-five miles to the eastern limits of the Tertiary formation, the eastern and western portions lying within Cretaceous areas.

Tyrrell (**84**, 60E) gives the formation at the mouth of the Blindman river, the locality from which many of the specimens have been derived, as consisting of horizontal, light-grey sandstones with grey and olive shales, fifty-two feet in thickness. The olive shales near the top, and having a thickness of fifteen feet, contain fossils. In discussing the possible age of the formation, he expresses the opinion that it is early Eocene, and designates it as the Paskapoo series which includes all the rocks above the Edmonton and embraces Dawson's Porcupine Hills and Willow Creek series, together with all but the lowest 700 – 900 feet of his St. Mary River series. As exposed on the Little Red Deer, the Paskapoo has a total thickness of 5,700 feet (**84**, 135 E). The origin of the series is explained by the statement that at the close of the Edmonton the present plains area was lifted from the bottom of the Pierre sea with the formation of the Rocky mountains along a line near the western edge, but again sank beneath the sea. This area, now cut off from the main ocean, formed a great inland lake upon the sinking floor of which there were deposited sandstones and sandy shales with a thickness of several thousand feet. (**84**,137E).

The first record of plants from the Red Deer river was published by Sir William Dawson in connexion with Mr. Tyrrell's report in 1887 (**29**, 136E) :—

In 1897 Mr. L. M. Lambe placed in my hands a collection of Red Deer plants from the mouth of the Blindman river, and in 1902 these were published together with others in the collection of the Peter Redpath Museum (**75**, 46). Combining these various lists, the following represents the flora of the Red Deer region as now known :—

1. *Alnites grandifolia*, Newb.
2. *Carya antiquorum*, Newb.
3. *Catalpa crassifolia*, Newb.
4. *Cercis parvifolia*, Lesq.
5. *Clintonia oblongifolia*, Penh.
6. *Cornus rhamnifolia*, O. Web.
7. *Corylus americana fossilis*, Newb.
8. *macquarrii*, (Forbes) Heer.
9. *Equisetum arcticum*, Heer.
10. *Ficus* sp.
11. *Glyptostrobus europæus*, (Brongn) Heer.
12. *Juglans* sp.
13. *acuminata*, A. Br.
14. *laurifolia*, Knowlton.

15. *Juglans leconteana*, Lesq.
16. *occidentalis*, Newb.
17. *Lastrea fischeri*, Heer.
18. *Maianthemum grandifolium*, Penh.
19. *Nelumbium saskatchuense*, Dn.
20. *Osmunda macrophylla*, n. sp.
21. *Phyllites carneosus*, Newb.
22. *Populus acerifolia*, Newb.
23. *arctica*, Heer.
24. *cuneata*, Newb.
25. *daphnogenoides*, Ward.
26. *obtrita*, Dn.
27. *richardsoni*, Heer.
28. *ungeri*, Lesq.
29. *Quercus* sp.
30. *ellisiana*, Lesq.
31. *Salix laramiana*, Dn.
32. *Sapindus*, sp.
33. *Sequoia couttsiæ*, Heer.
34. *langsdorfii*, (Brongn) Heer.
35. *nordenskioldii*, Heer.
36 *Sphenopteris bloemstrandi*, Heer.
37. *guyotti*, Lesq.
38. *Sphenoxamites oblanceolatus*, n. sp.
39. *Taxodium distichum miocenum*, Heer.
40. *occidentale*, Newb.
41. *Typha* sp.
42. *Viburnum ovatum*, n. sp.
43. *asperum*, Newb.
44. *saskatchuense*, Dn.

EDMONTON COAL BEDS AND THE NORTH SASKATCHEWAN RIVER.

These two localities may be treated as one. The North Saskatchewan river enters the Laramie area on the west about sixty miles north of the Red Deer river and one hundred miles north of Cochrane. The flora from this locality is not very important, indeed the only information available is derived from a small collection of plants obtained by Dr. Selwyn in 1874, and determined by Sir William Dawson, (**15**,51). Among them he recognized a species of *Taxes*, one of *Cupressoxylon* and some other species of coniferous wood, but he did not attempt their specific determination. He, however, concludes that they are all modern species and probably Tertiary.

GREAT BEAR RIVER, MACKENZIE RIVER BASIN, NORTHWEST TERRITORIES.

Probably the earliest account of the Tertiary flora of Canada is that given by Sir John Richardson in 1851 (**80**) in connexion with his search for Sir John Franklin. In his report he gives several beautifully executed and accurate figures of plants, and among others a very fine specimen of *Taxodium occidentale*. All his specimens were obtained from the Mackenzie basin within a limited exposure about the lower portion of the Great Bear river. This locality is found in long. 125°—126° west and just below the 65th parallel of latitude. It

forms an isolated outlier of the Laramie formation, and as indicated on the geological map it appears to measure thirty-six miles east and west, and twenty-eight miles north and south.

McConnell (**68**) who examined this area in 1888, describes it as located about twenty miles south of Old Fort Norman, where the soft clays and sands of the Bear River Tertiary beds are first seen. The lowest beds consist of indurated sands of a yellowish and greyish colour. These are overlaid with 30-40 feet of bluish and yellowish sandy shales, above which there are 3-4 feet of lignite. This latter is succeeded by 15 feet of whitish-weathering arenaceous shale which is very soft but rich in fossil leaves. The total thickness of the Tertiary beds is one hundred feet and five inches. He directs attention to the fact that the lignite beds were on fire at the time of his visit, and that " they have been burning since the locality was first visited by Sir Alexander Mackenzie just a century ago." This combustion has produced an alteration similar to that observed in the region of Porcupine creek and elsewhere, with the result that the enclosing shale is hardened and reddened. In these baked shales there are many beautifully preserved specimens of leaves (**68**, 95–96D).

From Bear river, the Tertiary beds extend along the Mackenzie river almost to the foot of Bear mountain where they are replaced by Devonian limestones and shales, but on the south they reappear at a point about twelve miles below Bear river and present an exposure along the valley for about half a mile when they disappear, though their actual extension may be somewhat greater. The total thickness of the formation, as a whole, is held to be not less than 600 feet, and the area itself is given a somewhat greater value than originally assigned—forty miles along the Mackenzie from north to south, and a width of thirty to forty miles (**68**,100D). The Tertiary beds to be seen at Old Crow river and at Fishing river are regarded as of the same age, forming a part of the same basin. At the head of the Ramparts, these rocks overlap the Cretaceous and rest directly upon hard limestones and quartzites which are probably Palæozoic. Below Howling-Dog-Rock, at the mouth of the Porcupine, the rocks are similar to those of the Ramparts. The width of the Tertiary basin at this point does not exceed seven miles, though the appearance of the country indicates that it extends much farther (**68**,127-132).

Discussing the age and formation of these beds, McConnell regards them as lacustrine in origin, and in their lithological and stratigraphical aspects they "have a much closer resemblance to the Miocene of the Cypress hills and neighbouring areas than of the Laramie with which their fossils correlate them."

At the mouth of the Bear river, instead of a conformable passage from the Cretaceous to the Tertiary, as in the area of the Great plains, there is evidence that the former was elevated and subjected to a prolonged denudation before the latter was deposited. In order to reconcile the stratigraphical position of the Bear River beds with a Laramie age, it will be necessary to assume that this part of the continent was, towards the end of the Cretaceous period, affected by extensive movements of elevation and depression in which the central part did not participate. (**68**, 100*d*.)

The collection of plants made by Sir John Richardson was placed in the hands of Prof. Oswald Heer, for determination. Four specimens of fossil wood were in the collection. These were handed to Dr. C. Schröter for determination by microscopical study, and he found them to embrace a *Sequoia*, a *Larix*, a *Gingko* and a *Platanus*. They are all illustrated by accurately drawn figures from which it is possible to confirm the general conclusions

reached, though there seems to be some doubt as to the *Gingko.* With the exception of the last which was not specifically named, and of the *Platanus* which was regarded as identical with leaves of the same genus found in association, these woods were held to represent new species and were so named.

Heer's results were published in 1868 (**34**) and again in 1880 (**42**), and his original list may therefore be regarded as constituting the beginning of our acquaintance with this ancient but wide-spread flora within the limits of Canada. It was nevertheless only shortly after, and before the publication of Heer's second list, that Sir William Dawson made his first determinations of Laramie plants, based upon collections made by Dr. G. M. Dawson in 1873 (**26**); and from that time onward, our knowledge of this flora somewhat rapidly increased. Heer's list, including woods by Schröter, is as follows:—

1. *Antholithes amissus*, Heer.	Fruit.
2. *Betula macrophylla*, Goepp.	Leaves.
3. *Carpolithes seminulum*, Heer.	Fruit.
4. *Corylus macquarrii*, (Forbes) Heer.	Leaves.
5. *Gingko* sp.	Wood.
6. *Glyptostrobus ungeri*, Heer.	Leaves.
7. *Hedera maclurii*, Heer.	Leaves.
8. *Juglans acuminata*, A. Br.	Leaves.
9. *Larix johnseni*, Schröter.	Wood.
10. *Magnolia nordenskioldii*, Heer.	Leaves.
11. *Phyllites aceroides*, Heer.	Leaves.
12. *Platanus aceroides*, Goepp.	Wood and leaves.
13. *Populus arctica*, Heer.	Leaves.
14. *hookeri*, Heer.	Leaves.
15. *richardsoni*, Heer.	Leaves.
16. *Pterospermites spectabilis*, Heer.	Fruit.
17. *Quercus olafseni*, Heer.	Leaves.
18. *Salix raeana*, Heer.	Leaves.
19. *Sequoia canadensis*, Schröter.	Wood.
20. *langsdorfii*, (Brongn). Heer.	Leaves.
21. *Smilax franklini*, Heer.	Leaves.
22. *Tilia malmgreni*, Heer.	Leaves.
23. *Viburnum nordenskioldii*, Heer,	Leaves.
24. *Xylomites borealis*, Heer. On leaves of *Pterospermites spectabilis.*	

All of these plants were regarded by Heer as of Miocene age.

In 1888, McConnell made a re-examination of the bed from which Richardson obtained his plants. He found it entirely covered with water, as was also the nine foot seam of lignite mentioned by that early explorer. (**28**, 69; **68**, 99D). He nevertheless brought away a very good collection of plants which were subsequently determined and reported upon by Sir William Dawson (**17**, 96D). The list appears below:—

1. *Callistemophyllum latum*, Dn.
2. *Carpolithes* sp.
3. *Leguminosites ? borealis*, Dn.
4. *Nordenskioldia borealis*, Heer.

5. *Populus arctica*, Heer.
6. *latior*, Al. Br.
7. *hookeri*, Heer.
8. *Pteris sitchensis*, Heer.
9. *Sequoia langsdorfii*, (Brongn) Heer.
10. *Taxites olriki*, Heer.

In addition to these recognizable specimens, there were some pyritized woods of doubtful character, but apparently representing *Sequoia canadensis*, *Platanus aceroides* and *Gingko* as determined by Schröter.

It will be observed that although the collection was not an extensive one, it nevertheless served to extend the original list in important ways, since it added no less than six species. In summing up the results of his studies, Dawson (**17**,98D) concludes that these facts indicate a very strong resemblance of the flora of the Mackenzie River beds to that of the Laramie and other parts of Canada and the United States, and also with the Tertiary of Greenland, Spitzbergen, Alaska and the Hebrides. They thus confirm the inferences as to this similarity and as to the Lower Eocene age of the Upper Laramie as stated by him in the Report on the Forty-ninth Parallel and in subsequent publications.

The seven localities thus dealt with all lie within the general region commonly designated as the Laramie basin and regarded as of Lower Eocene or Lignite Tertiary age, and to a consideration of this question, attention will be given in a subsequent page.

THE SIMILKAMEEN VALLEY.

The formation within the region of the Similkameen valley occupies a basin of an irregularly circular form with an extension of about fifteen miles east and west, and fourteen miles in its greatest northern and southern extension. According to the indications of the geological map, the eastern half is regarded as comprising Tertiary volcanic rocks, while the western half is sedimentary. Dawson observes (**9**,112B) that the "Tertiary rocks of this part of the province do not form such extensive, unbroken sheets as they do farther north, a fact probably due to the more mountainous and rugged nature of the country at the time of their deposition, and also to extensive and severe disturbance and denudation subsequent to that time. They are for the most part igneous rocks, but include thick masses of argillaceous and arenaceous beds with lignites and coals. It is by no means improbable that the Tertiary rocks of this part of British Columbia may eventually admit of separation into several distinct series representing different stages in the Cainozoic period, but palæontological evidence of this is yet wanting."

There is no region in western Canada that has received such searching and extensive study of its flora as the Similkameen basin, and it will be convenient to consider it with reference to the various special localities examined. These are :—

1. The Similkameen river.
   This includes plants not only from the main river, but from some other localities not otherwise designated.
2. The Tulameen or North Similkameen river, including
   (*a*) Vermilion cliff.
   (*b*) Princeton.

3. The Similkameen river, embracing
    (*a*) Whipsaw creek.
    (*b*) Nine-mile creek.

1. *Similkameen River.*

The Similkameen river is located about 49° 30′ N, and 120° 30′ W. From Vermilion forks to the eastern limits of the basin is only a distance of about seven miles, and the Tertiary exposures are therefore brought within a narrow extent of territory. The flora as determined by Sir William Dawson in 1890 (**23**, 91) is very limited but includes some representative species.

1. *Antholithes* sp.
2. *Betula* sp.
3. *Cyperites* sp.
4. *Equisetum similkamense*, Dn.
5. *Ficus* sp.
6. *Magnolia* sp.
7. *Myrica cuspidata*, Lesq.
8. *Populus daphnogenoides*, Ward.
9. *obtrita*, Dn.
10. *Quercus* sp.
11. *Vaccinophyllum questum*, Dn.

This list has now been extended through the collections of Mr. Lambe in 1906 with the following result:—

1. *Betula* sp.
2. *Carpinus grandis*, Ung.
3. *Carya antiquorum*, Newb.
4. *Comptonia columbiana*, Dn.
5. *Cyperites* sp.
6. *Myrica cuspidata*, (Lesq.) Dn.
7. *Nelumbium pygmæum*, Dn.
8. *Osmunda regalis*, L.
9. *Phragmites* sp.
10. *Populus obtrita*, Dn.
11. *rotundifolia*, Newb.
12. *zaddachi*, Heer.
13. *Sequoia acuminata ?* Lesq.
14. *Taxodium distichum miocenum*, Heer.
15. *occidentale*, Newb.
16. Rhizomes ? and very fine rootlets of a monocotyledonous plant.
17. Obscure impressions showing flattened scars in a spiral arrangement, probably the remains of a cone.

1. *Tulameen or North Similkameen River.*

The Tulameen or North Similkameen river is one of the most important of the upper branches of the Similkameen which it joins near Princeton, once known as Vermilion Forks. Only a limited portion of this branch, about eight miles in extent and

near its mouth, lies in the Tertiary formation. Vermilion cliff is three miles above the forks and is composed of rocks of very singular aspect about two hundred feet high and embracing Tertiary strata one hundred and fifty feet in thickness. It is much resorted to by Indians for the purpose of securing paint material, and Dawson (**8**, 130-132) informs us that the colour is probably due to combustion of a bed of lignite in its lower part, after the manner frequently found in the Tertiary Bad Lands east of the Rocky mountains, and also at Quesnel, British Columbia. The beds were evidently laid down in the bottom of a lake into which very numerous and copious mineral springs issued, and the deposit resulting from their action is siliceous with a large proportion of calcareous matter. The lignite beds, the combustion of which produced an alteration of the surrounding rocks, is seven feet in thickness.

At Vermilion Forks, according to the observations of Bauermann, made in 1882 (**2**, 32B), the formation is characterized by the presence of sandstones underlying beds of fine white sandstones containing twigs and fragments of coniferous plants.

The first botanical examination of this locality was made by Sir William Dawson in 1877 (**21**, 186B), when he recorded the occurrence there of—

1. *Myrica partita*, Lesq.
2. *Paliurus ?* sp.
3. *Taxodium distichum miocenum*, Heer.

In 1890 the same author made a very important addition to this list by the recognition of not less than ten new species (**23**, 75-91) as follows :—

1. *Alnites curta*, Dn.
2. *Ceanothus* sp.
3. *Cinnamomum* sp, probably *C. affine.*
4. *Comptonia columbiana*, Dn.
5. *Gingko adiantoides*, Ung.
6. *Glyptostrobus* sp., probably *G. europæus.*
7. *Planera longifolia*, Lesq.
8. *Nelumbium pygmæum*, Dn.
9. *Quercus dallii*, Lesq.
10. *Ulmites pusillus*, Dn.

No further addition to the flora of this portion of the Similkameen basin was made until Mr. L. M. Lambe brought out a very important collection of specimens in 1906, and these constitute an essential part of the present report. They were found to include :—

1. *Æsculus ?* sp. Fruit.
2. *Acer* sp. Fruit.
3. *Acer* sp. Fruit.
4. *Alnus alaskana*, Newb.
5. *Betula* sp. Cone.
6. *Carpinus grandis*, Ung.
7. *Carpolithes* sp. Probably some coniferous seed.
8. *Carpolithes* sp.
9. *Cinnamomum affine*, Lesq.
10. *Comptonia columbiana*, Dn.

11. *Cornus orbifera*, Heer.
12. *Cratægus tulameenensis*, n. sp. Fruit.
13. *Cycadites ?* sp. One pinna.
14. *Cyperites* sp. Stems and leaves.
15. *Cyperites* sp. Stems and leaves.
16. *Ficus asiminæfolia*, Lesq.
17. *populina*, Heer,
18. *Gingko adiantoides*, (Ung.) Heer.
19. *Glyptostrobus europæus*, (Brongn.) Heer.
20. *Magnolia* sp.
21. *Musaphyllum complicatum*, Lesq.
22. *Pinus* sp. Scale of cone.
23. *Pinus* sp. Seed much broken.
24. *trunculus*, Dn.
25. *Planera longifolia*, Lesq.
26. *Populus arctica*, Lesq.
27. *cuneata*, Newb.
28. *cordata*, Newb.
29. *latior*, A. Br.
30. *latior cordifolia*, Heer.
31. *zaddachi*, Heer.
32. *Potamogeton ? verticillatus*, Lesq.
33. *Quercus laurifolia*, Newb.
34. *Sequoia* sp. Staminate flowers and cone scale ?
35. *angustifolia*, Lesq.
36. *heerii*, Lesq.
37. *langsdorfii*, (Brongn) Heer.
38. *Taxodium distichum miocenum*, Heer.
39. *Typha latissima*, A. Br.
40. *Ulmus* sp. Fruit.
41. *Ulmus minuta*, Goepp.
42. Roots of an aquatic plant.
43. Metamorphosed and indurated clays and sandstones containing a collection of stems, leaves and fruits in an unrecognizable condition.

3. *Similkameen River.*

On the Similkameen river, two important localities are recognized, Whipsaw creek and Nine-mile creek. The former enters the Similkameen basin at its southwest corner and joins the Similkameen a short distance above Vermilion Forks, after traversing about five miles of the Tertiary area. Nine-mile creek enters the Whipsaw from the west, about one mile and one-half above the junction of the latter with the Similkameen, and about ten miles south of Vermilion Forks. Dawson observes (8,130 B) that most of the beds of the Similkameen are too soft for the preservation of plant remains, but one layer of hardened, siliceous matter contains many perfectly preserved specimens. At Nine-mile creek, from which most of the specimens have been obtained, there is a small section of hard, laminated clays between layers of soft arenaceous clays. There are some remains of insects to be found here, and many plants.

The only knowledge of the flora of this locality is derived from the list of plants published by Sir William Dawson in connexion with Dr. G. M. Dawson's report on an explor-

ation of Southern British Columbia. (**21**,186B.) Although the list is not a large one, it embraces several important species not obtained from other localities.

1. *Betula stevensoni*, Heer.
2. *Carpinus grandis*, Ung.
3. *Corylus* sp.
4. *Equisetum similkameense*, Dn.
5. *Glyptostrobus europœus*, (Brongn) Heer.
6. *Juglans* sp. Allied to *J. rugosa*, Heer.
7. *Leguminosites* sp. Very like *L. arachnoides*, Lesq.
8. *Myrica* sp.
9. *Nelumbium* sp. Probably *N. pygmœum*, Dn.
10. *Platanus* sp.
11. *Populus arctica*, Heer.
12. *latior*, Heer.
13. *Sapindus* sp. Allied to *S. angustifolius*, Heer.
14. *Sequoia brevifolia*, Heer.
15. *Sequoia langsdorfii*, Heer,
16. *Taxodium distichum miocenum*, Heer.
17. *Thuya* sp.

Sir William Dawson has expressed the opinion that the Similkameen beds are of Miocene age (**32**,187B), and this view was adopted by Dr. G. M. Dawson in 1894 (**9**,75–76B), in the statement that the Similkameen beds are Lower Miocene or Oligocene. He refers to the fact that up to that time, " nearly all the fossils collected from the interior of British Columbia are from localities in the Similkameen valley near the confluence of the Tulameen, all of which are parts of a Tertiary basin not yet traced into connexion with any other, and which may have been originally a distinct lake. It lies nearly fifty miles beyond the southern edge of the Kamloops sheet, and is now included in the drainage basin of the Columbia river."

" What has been said with regard to the existence of two well marked horizons in the Kamloops sheet appears to make it probable that the Similkameen beds may correspond in time with one or the other, and their appearance and mode of occurrence accord best with the hypothesis that they represent the Lower Coldwater : but at the present this is merely a conjecture." The sequence which he gives in connexion with these statements makes his position clear (**9**,76B).

Sequence of Tertiary strata of the Similkameen basin.

(After Dawson.)

	Feet.
Early Pliocene—	
Later Miocene including Tranquille group....... Nicola valley, &c......	4,100
Earlier Miocene—	
Lower part of the volcanic series, Kamloops lake. Nicola valley. Clear mountains...........	5,300
Oligocene. Coldwater group—	
Confluence of the Coldwater and Nicola, Copper creek.............................. Hat creek....................................	5,000
	14,400

It should not be overlooked that both Scudder and Cope have contributed evidence of importance to the stratigraphical relations of these beds. In 1894 (**9**,75,76B) Scudder recognized sixteen species of insects from the Similkameen area, and on this basis concluded that the formation must be of Oligocene age. In the same year Cope recognized the occurrence of Amyzon which he regarded as proving the equivalency of the Similkameen beds with the Amyzon beds of Oregon. Although he hesitated to express a final opinion, he was led to infer an Oligocene age for the formation.

Finally, the more recent recognition by Lambe (**60**,151-155) of two species of Amyzon obtained by Dr.G.M. Dawson, the one from the mouth of the Similkameen in 1888, and the other from Kamloops lake in 1890, while Mr. J. B. Hobson obtained both species from the Horsefly river in 1895, has led him to conclude that Cope's correlation of the Similkameen beds with the Amyzon beds of Colorado and Nevada is correct, and that the beds of the Horsefly and Tranquille rivers are undoubtedly of the same age.

Kettle River.

The Kettle river lies to the eastward of the Similkameen basin. Its course runs through a volcanic area, and near the International Boundary it passes through a small area which is usually regarded as Miocene. It measures about eighteen miles north and south, and fifteen miles east and west. The town of Midway is situated at its southeastern extremity, and it is from its vicinity that most of the plants known to the region have been obtained.

Our only information respecting the flora of this small basin has been derived from a collection made by Dr. R. A. Daly in 1905 in connexion with the work of the Boundary Commission for that year, and recently published in the Transactions of the Royal Society of Canada (**78**). Although small, this collection is noteworthy for the large proportion of specimens in the form of silicified woods, the structure of which was often remarkably well preserved. The plants found are:—

1.	*Betula* sp.	
2.	*Cupressoxylon macrocarpoides*, Penh.	
3.	*Cyperites* sp.	
4.	*haydenii*, Lesq.	
5.	Fern stipes.	
6.	*Picea columbiensis*, Penh.	Leaves and cone.
7.	*Phragmites* sp.	
8.	*Pinus columbiana*, Penh.	Cones and wood.
9.	*Potamogeton* sp.	Fruit.
10.	*Taxodium distichum miocenum*, Heer.	
11.	*Ulmus* sp.	
12.	*Ulmus columbiensis*, Penh.	Wood.
13.	*proto-americana*, Penh.	Wood.
14.	*proto-racemosa*, Penh.	Wood.

From the evidence then at hand the conclusion was reached that the Kettle River area is of Eocene age.

Nicola Basin.

The Nicola basin includes four areas from which fossil plants have been derived—

1. Coal gully.
2. Quilchena, which is essentially the same as the last.
3. Coldwater river.
4. Stump lake.

1. *Coal Gully.*

Coal gully, near Coutlee, is situated on the Nicola river eight miles west of Nicola lake. It is in a sedimentary area with volcanic formation and near the junction of Coldwater river with the Nicola. The former flows through volcanic Tertiary from the south, for more than twenty-four miles. In the winter of 1904 Penhallow determined a small collection of plants from this locality, derived from the work of Ells and Johnston during the previous summer. There were found—

1. *Ficus* sp.
2. *Ulmus* sp.
3. *Taxodium distichum miocenum*, Heer.

The very limited representation and the imperfect character of the material, which prevented recognition of anything except the very well characterized *Taxodium*, made it impossible to draw any conclusions of value as to the probable age of the formation. More recent collections by Lambe during the summer of 1906 have enabled us to gain a better conception of the character of this flora from which it will now be possible to derive inferences of value. This collection includes:—

1. *Phragmites* sp.
2. *Populus acerifolia*, Newb.
3. *polymorpha*, Newb.
4. *Sequoia langsdorfii*, (Brongn) Heer.
5. *Taxodium distichum miocenum*, Heer.
6. *Thuya interrupta*, Newb.
7. *Typha latissima?* Al. Br.
8. *Ulmus speciosa*, Newb.
9. Fragments of unrecognizable stems.

2. *Quilchena.*

Quilchena on the Nicola river represents essentially the same locality as the last. The first collection from this locality was made by Ells and Johnston in 1904 but particulars have not as yet been published. It was nevertheless a fairly large and representative collection, and is of great value for stratigraphical purposes. In it there were found—

1. *Alnites curta*, Dn.
2. *Betula angustifolia*, Newb.
3. *heterodonta*, Newb.
4. *Carpinus grandis*, Ung.
5. *Carya antiquorum*, Newb.
6. *Cornus newberryi*, Hollick.
7. *Gingko digitata*, (Brongn) Heer.
8. *Picea quilchenensis*, n. sp.
9. *Pinus trunculus*, Dn.
10. *Populus obtrita*, Dn.
11. *polymorpha*, Newb.

12. *Quercus castaneopsis*, Newb.
13. *Rhamnus* sp.
14. *quilchenensis*, n. sp.
15. *Salix orbicularis*, n. sp.
16. *Sassafras* sp.
17. *Sequoia nordenskioldii*, Heer.
18. *Taxodium distichum miocenum*, Heer.
19. *occidentale*, Newb.
20. *Thuya interrupta*, Newb.
21. *Ulmus speciosa*, Newb.
22. Grass ? seeds.
23. Fragments of dicotyledonous stems, commonly branching and often showing carbonized fragments of bark.

In 1906 Lambe secured a much larger representation of the flora from this locality, consisting of upwards of sixty recognizable genera and species. As now determined they are as follows :—

1. *Alnus* sp.
2. *serrulata fossilis*, Newb.
3. *Amygdalus gracilis*, Lesq.
4. *Alnites* sp.
5. *Aralia acerifolia*, Lesq.
6. *Carpinus grandis*, Ung.
7. *Carpolithes* sp.
8. *Carpolithes dentatus*, Penh.
9. *Carya antiquorum*, Newb
10. *Castanea intermedia*, Lesq.
11. *Corylus americana*, Walt.
12. *Comptonia* sp.
13. *Cornus orbifera*, Heer = C. *suborbifera*, Heer.
14. *Cyperites* sp.
15. *Dryophyllum stanleyanum*, Dn.
16. *Ficus decandolleana*, Heer.
17. *ungeri*, Lesq.
18. *Gingko adiantoides*, (Ung.) Heer. Fruit and leaves.
19. *Glyptostrobus europæus*, (Brongn) Heer.
20. *Myrica (Comptonia) cuspidata*, (Lesq.) Dn.
21. *Pinus lardyana*, Heer.
22. *lopatini*, Heer.
23. *trunculus*, Dn.
24. sp. Seeds.
25. *Populus acerifolia*, Newb.
26. *cordata*, Newb.
27. *genetrix*, Newb.
28. *mutabilis oblonga*, Heer.
29. *Populus nebrascencis*, Newb.
30. *obtrita*, Dn.
31. *Quercus consimilis*, Newb.
32. *Prunus merriami*, Knowlton.
33. *Rhamnus* sp.
34. *elegans*, Newb.

35. *Rhamnus gaudini*, Heer.
36. *Salix perplexa*, Knowlton.
37. *Rhamnus varians*, Goepp.
38. *Sequoia* sp.
39. *angustifolia*, Lesq.
40. *heerii*, Lesq.
41. *nordenskioldii*, Heer.
42. *Taxites olriki*, Heer.
43. *Taxodium distichum miocenum*, Heer.
44. *occidentale*, Newb.
45. *Thuya interrupta*, Newb.
46. *Typha latissima*, Al. Br.
47. *Ulmus speciosa*, Newb.
48. *Vitis rotundifolia*, Newb.
49. *Zanthoxylum spireæfolium*, Lesq.
50. Stems of an undeterminable character.
51. Fruit of a sedge?

3. *Coldwater River.*

The only record from this locality is contained in Sir William Dawson's account of the Similkameen flora published in 1890 (**23**, 75-91) and is as follows :—

1. *Sequoia* sp.
2. *Taxodium distichum miocenum*, Heer.

4. *Stump Lake.*

The only record from this place is to be found in the same publication as the last, and it is of a similarly limited character.

1. *Acer* sp. Fruit.
2. *Acerites negundifolium*, Dn.
3. *Azollophyllum primævum*, Penh.
4. *Carpinus grandis*, Ung.
5. *Carpolithes dentatus*, Penh.
6. *Glyptostrobus*, sp. Probably *G. europæus.*
7. *Pinus trunculus*, Dn.

Dr. Dawson (**9**, 68-71B) directs attention to the probability that the often vertical rocks of the Coldwater group antedate the period of volcanic activity. At Coal gully the coal bearing rocks, which attain a thickness of 424 feet, have been considerably disturbed both by flexure and faulting (**8**,126B), and although the Coldwater beds conform to the underlying Cretaceous, there is every reason to believe that an unconformity due to orogenic movement and erosion separates them from all the other representatives of the Tertiary. (**9**, 71B).

Horsefly River.

The Horsefly river is about sixty-five miles southeast of the mouth of the Quesnel river, and for about fifty miles it runs through an area which has not been fully determined. On the geological map for 1901 the formation is provisionally indicated as Cambro-Silurian and Triassic. The first record of plants from this locality was based upon a collection made by Dr. G. M. Dawson in 1894, and published in 1902 (**75**,68). The following species were then determined :—

1. *Acer dubium*, Penh
2. *Alnites curta*, Dn.
3. *Aralia notata*, Lesq.
4. *Betula stevensoni*, Lesq.
5. *Castanea castaneæfolia*, (Ung.) Knowlton.
6. *Nelumbium pygmæum*, Dn.
7. *Pinus trunculus*, Dn.
8. *Planera longifolia*, Lesq.
9. *Pseudotsuga miocena*, Penh.
10. *Sequoia langsdorfii*, (Brongn) Heer.
11. *Taxodium distichum miocenum*, Heer.

In 1906 Lambe obtained a very large collection from this area, embracing the following species:—

1. *Acer* sp. Fruit.
2. sp. Fruit.
3. sp. Fruit.
4. *columbianum*, n. sp.
5. *Alnus carpinoides*, Lesq.
6. *Carex* sp. Seed.
7. *Carpolithes* sp.
8. *Carpolithes dentatus*, Penh.
9. *Carya antiquorum*, Newb.
10. *Corylus americana*, Walt.
11. *macquarrii*, (Forbes) Heer
12. *Cinnamomum affine*, Lesq.
13. *Crataegus columbiensis* n. sp.
14. *Cyperites* sp.
15. *Ficus* sp.
16. *asarifolia*, Ett.
17. *populina*, Heer.
18. *Gingko adiantoides*, (Ung.) Fruit and Leaves.
19. *Glyptostrobus europœus*, (Brongn.) Heer.
20. *Grewia crenata*, (Ung). Heer.
21. *Juglans occidentalis*, Newb.
22. *Leguminosites arachnoides*, Lesq.
23. *Myrica* sp.
24. *personata ?* Knowlt.
25. *Onoclea sensibilis*. Newb.
26. *Pinus* sp. Seeds.
27. sp. Base of scale and two seeds. Probably of *P. lopatini*.
28. *trunculus*, Dn.
29. *Planera crenata*, Newb.
30. *longifolia*, Lesq.
31. *Populus* sp.
32. *latior*, Al. Br.
33. *Quercus* sp.
34. *Rhamnus* sp.
35. *Salix varians*, Goepp.
36. *Sequoia* sp.

37. *Sequoia angustifolia*, Lesq.
38. *heerii*, Lesq.
39. *nordenskioldii*, Heer.
40. *Taxodium distichum miocenum*, Heer.
41. *occidentale*, Newb.
42. *Typha latissima*, Al. Br.
43. *Ulmus minuta*. Leaves and fruit.
44. *speciosa*, Newb.
45. *Vitis olriki*, Heer.

QUESNEL RIVER.

The Quesnel river enters the Fraser at Quesnel passing through about eight or ten miles of a formation usually regarded as Miocene. Of the formation at this point, Dr. Dawson (**10**,257) observes that at a place one-half mile below Quesnel, on the Fraser, the lignite has entirely disappeared by combustion, and the clays and sands have been baked and caused to assume various shades of yellow and red. Rocks resembling ordinary brick and biscuit porcelain are most abundant, but some layers are semi-vitrified and others containing much iron have melted to a vesicular slag.

Our knowledge of the flora of this formation is based upon two collections made by Dr. G. M. Dawson in 1871 and 1875, and determined by Sir William Dawson. In his report upon the first collection from the mouth of the Quesnel (**18**, 59) he reports :—

1. *Acer* sp.
2. *Platanus* sp. Wood and leaves.
3. *Populus* sp. Wood and leaves.
4. *Pterospermites* sp.
5. *Quercus* sp.

In 1875 he extended this list and gave a more specific indication of the types found. (**16**, 259-260). The specimens were all small and imperfect, but they admitted of a recognition of the following species :—

1. *Acer* sp. Probably comparable with *A. grossedentatum* of the European Tertiary.
2. *Betula* sp. Probably *B. prisca*.
3. *Carya* sp. Nut.
4. *Castanea castaneæfolia*, (Ung.) Knowlton.
5. *Dombeyopsis islandica*, Heer.
6. *Fagus antipofi*, Abich.
7. *feroniæ*, Ung.
8. *Juglans* sp. Nut.
9. *nigella*, Heer.
10. *Nordenskioldia borealis*, Heer.
11. *Nyssidium ?* sp.
12. *Platanus aceroides*, Goepp.
13. *Populus arctica*, Heer.
14. *Quercus* sp.
15. *pseudocastanea*, Goepp.
16. *Rhamnus* sp.
17. *Rhamnus* sp. Undescribed but regarded as near to *R. alternoides*.
18. *Taxodium ?* sp.

These plants are said to be largely identical with those from the Miocene of Alaska as described by Heer, with points of resemblance to those from Bellingham bay as described by Newberry. "Whether the formation is Miocene or somewhat older, admits of doubt." (**15**, 259-260).

Cariboo Mine.

Cariboo, on the Quesnel river, is about midway between Quesnel and Quesnel lake. It is located in an area of undetermined character, but generally defined as Cambro-Silurian and Triassic. Very few plants have been obtained from this locality, and such information as bears upon it will appear in the discussion of species and elsewhere.

Blackwater River.

The Blackwater river runs from long. 125° 30′ west, somewhat north of latitude 53° north, and forms a junction with the Fraser river 25 miles north of Quesnel. For about one hundred and ten miles, it passes through a recognized Tertiary formation usually regarded as Miocene, thence for the remainder of its course—thirty-seven miles—it passes through an undetermined area generally indicated as Cambro-Silurian and Triassic, but without which there are two very small Tertiary areas. Collections of plants made by Dr. G. M. Dawson in 1875, were reported upon by Sir William Dawson (**15**, 259-260) and found to contain :—

1. *Acer* sp. A seed two inches long, probably of *A. macropterum*, (Ung.) Heer.
2. *Castanea castaneæfolia*, (Ung) Knowlton.
3. *Diospyros alaskana*, Schimp.
4. *Fagus* sp. Very like F. *feroniæ*.
5. *Pinus* sp. Two species represented by seeds.
6. *Taxodium occidentale*, Newb.
7. *Thuya* sp. Probably *T. interrupta*.

The resemblance of these plants to those from the Miocene of Alaska is pointed out, but doubt is expressed as to whether they are Miocene or not (**16**,259-260).

Tranquille River.

The Tranquille river runs north from the eastern end of Kamloops lake through a volcanic Tertiary for sixteen or more miles. It is distant from Coal brook about 44 miles, and it is about the same distance north of Coal gully. In discussing the origin of these rocks, Dr. G M. Dawson remarks (**9**,69B), "That these deposits antedate the period at which volcanic activity on a great scale began, is rendered evident by two circumstances. They include in their material no characteristic volcanic Tertiary rocks, while they appear without doubt to be affected by more pronounced folding than that affecting the volcanic rocks."

From a further discussion of their deposition we are led to consider that the Tertiary beds were deposited during an interlude in volcanic activity which, near the close of its first period, caused a blocking up of the drainage whereby lakes were formed from the impounded water. In these lakes the Tranquille beds were deposited, and they are chiefly developed in the vicinity of Kamloops lake (**9**,72B). The locality designated as Kamloops is therefore to be regarded as essentially synonymous with Tranquille or Tranquille river.

The original collections from the Tranquille were described by Sir William Dawson in 1890 (**23**,75-91) and were of very minor importance :—

1. *Ailanthophyllum inceratum*, Dn.
2. *Salix kamloopsiana*, Dn. Approaches *S. varians*, which it may be.
3. *Sequoia* sp.
4. *Taxodium distichum miocenum*, Heer.

Doubt is expressed as to the age of these plants, but it is thought that they may be Miocene.

It was not until 1906 that any very satisfactory collection of plants from this locality was made. During that summer Lambe succeeded in bringing together a very large number of specimens which have been studied and found to represent the following:—

1. *Alnus carpinoides*, Lesq.
2. *Andromeda delicatula*, Lesq.
3. *Betula* sp. A badly crushed catkin.
4. *heterodonta*, Newb.
5. *macrophylla*, Geopp.
6. *Carpinus grandis*, Ung.
7. *Carpolithes* sp.
8. *dentatus*, Penh.
9. *Carya antiquorum*, Newb.
10. *Cinnamomum affine*, Lesq.
11. *Corylus americana*, Walt.
12. *Cratægus tranquillensis*, n. sp.
13. *Cyperites* sp.
14. *Ficus asiminæfolia ?* Lesq.
15. *Gingko adiantoides*, (Ung.) Heer.
16. *Glyptostrobus europæus*, (Brongn.) Heer.
17. *Juglans rhamnoides*, Lesq.
18. *Picea* sp.
19. *Pinus trunculus*, Dn.
20. *Populus acerifolia*, Newb.
21. *cuneata ?* Newb.
22. *mutabilis oblonga*. Heer.
23. *zaddachi*, Heer.
24. *Planera longifolia*, Lesq.
25. *Rhamnus eridani*, Ung.
26. *Salix varians*, Goepp.
27. *Sequoia angustifolia*, Lesq.
28. *brevifolia*, Heer.
29. *heerii*, Lesq.
30. *langsdorfii*, (Brongn) Heer.
31. *Taxodium distichum miocenum*, Heer.
32. *occidentale*, Newb.
33. *Typha latissima*, Al. Br.
34. *Ulmus precursor*, Dn.
35. *Viburnum dentoni*, Lesq.
36. Various roots, stems and leaf scars.

Finlay River.

The Finlay river runs southeast from latitude 58° N. to the junction with the Peace river at latitude 56° N. For seventy-five miles it runs through a Laramie formation which

is about six miles in its greatest width, lying northwest and southeast from a little below Sifton pass to twenty-five miles below Fort Grahame.

McConnell (**67**,35–37C) informs us that Tertiary conglomerates interbedded with shales and sandstones occupy the bottom of the Finlay valley from the Ingencia river north to Tochieca, and thence northward along the latter. They reappear again on the Finlay a few miles farther west in a parallel valley which it enters and follows for some distance. They are also found on the Omineca from the Black canyon to its junction with the Tchutetzeca. These beds were probably deposited in Tertiary lakes.

The collection of plants secured by McConnell in 1894 were examined by Sir William Dawson and reported to include (**14**,36,37C)

1. *Grewia* sp.
2. *Leguminosites arachnoides*, Lesq.
3. *Sequoia couttsiæ*, Heer.
4. *langsdorfii*, (Brongn.) Heer.
5. *Viburnum asperum*, Newb.

He concluded that they indicated an Upper Laramie age.

Omineca River.

The Omineca river flows east from about 126° W. to a junction with the Finlay. The greater portion of its extent, for seventy-five miles, passes through an undetermined area, supposedly Cambro-Silurian and Triassic, with some volcanic and some limestone formation. From this locality, McConnell brought a small collection of plants in 1894, and Sir William Dawson was able to recognize among the specimens. (**14**,36-37)

1. *Arundo sp.*
2. *Platanus haydenii*, Lesq.
3. *Populus arctica*, Heer.
4. *nebrascencis*, Heer.
5. *speciosa*, Ward.
6. *Quercus* sp.
7. *Sequoia couttsiæ*, Heer.
8. *langsdorfii*, (Brongn) Heer.

Sequoia was reported as very abundant, and the conclusion was reached that the formation was Upper Laramie.

Coal Brook.

Coal brook is an isolated locality, forming an outlier of the general Tertiary area at Indian reserve on the North Thompson river, and distant about 128 miles north of the Similkameen. The rocks of this formation, as exposed on the left bank, are referred to by G. M. Dawson (**11**,20B) as old and chiefly much altered volcanic products with limestones and quartzites, while those on the right bank are in the main referable to the Tertiary volcanic period. Dr. Selwyn also deals with this formation in a general way (**83**,25).

The area constitutes an outlier of the Tertiary formation and is embraced in a hill 600 feet in height and about two and a half miles long. The beds are exposed by the cutting of Coal brook and the removal of a thick covering of boulder clay and drift. The whole

section at this point is not more than 150 feet thick, and the fossiliferous stratum occurs at about eight and a half feet below the surface, (**8**,113B). The matrix is a very hard, bluish, sandy clay through which stones of all sizes are scattered, and it shows a very rough and tumultuous deposit (**8**,140B).

Almost nothing is known respecting the flora of Coal brook, the only records being those of Sir William Dawson (**21**, 186 B) who recorded in 1877 the occurrence of *Populus arctica*, Heer, *P. latoir*, Heer and *P. subrotundus*, Lesq., with a possible *Sorbus.* In 1882 (**22**, 34) he repeated this list, showing that nothing had been added in the meantime, and that it represents the present state of our knowledge, with the exception that in 1894 he again observed the occurrence of *Populus arctica*, added *Populus genatrix*, Newb., and also recorded the presence of a *Rhus*, possibly *R. rosæfolia*, Lesq.

He observes that " the leaves from this place are in a matrix of grey, arenaceous shale, and are almost exclusively poplars."

Although he found it almost impossible to base any final conclusions upon such scanty information, he nevertheless concluded that "there can be no doubt, however, that they belong to the Tertiary period, and that they may be somewhat newer than the Laramie deposits of the plains. Like these they are associated with lignite." There seems little reason to doubt that these plants belong to the same volcanic Tertiary of more southern localities, from which a very much larger representation has been secured at various times, since identical species occur in both and the metamorphosed character of the matrix shows a similar influence.

Burrard Inlet.

The only other Tertiary deposit that claims consideration at this time is that at Burrard inlet. In 1895 (**20**, 137-161) Sir William Dawson described a small collection from that place and found :—

1. *Æsculophyllum hastingsense*, Dn.
2. *Asplenites* sp.
3. *Carex burrardiana*, Dn.
4. *vancouverensis*, Dn.
5. *Cyperites paucinervis*, Heer.
6. *Dryophyllum stanleyanum*, Dn.
7. *Ficus occidentalis ?* Lesq.
8. *shastensis ?* Lesq.
9. *Glyptostrobus europæus*, (Brongn) Heer.
10. *Juglans denticulata*, Heer.
11. *Lastræa fischeri*, Heer.
12. *Lygodium neuropteroides*, Lesq.
13. *Manicaria* sp.
14. *Neuropteris civica*, Dn.
15. *Planera crenata*, Newb.
16. *Platanus* sp.
17. *Populus balsamoides*, Goepp.
18. *rotundifolia*, Newb.
19. *Quercus d ntoni*, Lesq.
20. *Sabal campbellii*, Newb.
21. *Salix integra*, Goepp.
22. *varians*, Goepp.

In commenting upon this collection, Sir William Dawson remarks that the plants of Burrard inlet have a more modern aspect than those of the Nanaimo series or Upper Cretaceous. On the other hand they are distinct from the Oligocene or Older Miocene of the Similkameen and other parts of interior British Columbia. Between these they occupy an intermediate position and correspond to the Laramie of the plains east of the Rocky mountains. They thus also agree with the Atane beds of Greenland, the lignite series of the Mackenzie river and similar beds in Alaska, a conclusion reached independently by Newberry on the basis of the Puget group of Washington.

DESCRIPTION OF SPECIES.

Acer sp.

Bib: Trans. R. S. C., VIII, 1890, iv, 87, f. 20: Geol. Surv. Can., 1871-72, p. 59, 1875-7.

The genus *Acer*, as represented by its fruits, appears to be very generally distributed throughout the Tertiary areas of British Columbia. These fruits, nevertheless, vary greatly in size, from which the inference may be drawn that there are several species common to the region.

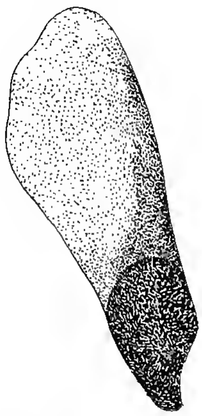

FIG. 1. *Acer* sp.
Imperfect fruit from the Horsefly. x 2.

On the Tulameen river Lambe found fruits which were only 8 mm. long and 6 mm. wide (Figure 2). These may be compared with and are probably the same as similar fruits (Figure 1) derived from the Horsefly river and measuring 10 mm. long by 4 mm. wide. Much larger fruits were also obtained from the Tulameen (Figure 3), and they are to be distinguished not only by their greater proportions, but also by their distinctive shapes. What seems to be a third species was obtained from the Horsefly river, and these seem to be identical with fruits from Stump lake described by Sir William Dawson in 1890.

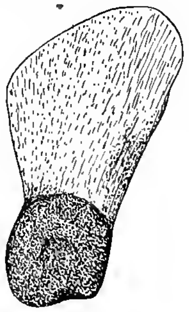

FIG. 2. *Acer* sp.
Fruit from the Tulameen River. x 2.

In 1871 and again in 1875, Sir William Dawson describes a fruit two inches in length, which was obtained from Quesnel. This he regarded as comparable with and possibly the same as *A. macropterum* of Heer, from Greenland.

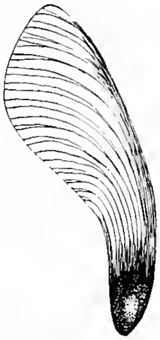

FIG. 3. *Acer* sp.
Fruit from the Tulameen River. x 1/1.

It is evident that the genus was not only widely distributed in the Tertiary of British Columbia, but that the number of species was not less than three or four, possibly more. The wide distribution of such fruits and their probable representation of several species have been noted by previous observers, notably by Heer, who figures a large number of forms to which he assigns specific names. The expediency of this seems very doubtful in view of the fact that there are no characters of sufficient importance and stability upon which to base specific distinctions, and it would seem far better to avoid the application of names that can serve no good purpose.

Many leaves of maples also occur in the Tertiary beds of British Columbia. Some of these are represented in the present collections while others have been recorded on previous occasions by Sir William Dawson. They are sometimes found in separate beds, but more commonly in association with fruits. Precisely similar associations have been noted by Heer for the Tertiary beds of Greenland and elsewhere, but so far as I am aware, it is as yet impossible to correlate such remains for the reason that they have not yet been found in direct connexion.

FIG. 4. *Acer* sp. Fruit from the Horsefly River.
Probably the same as fig. 2. 1/1.

Acer dubium, Penh.

Bib : Trans. R. S. C., VIII, 1902, iv, 68.

In 1902 Penhallow described the fruit of a maple under the name of *Acer dubium* because of the difficulty of correlating it with any previously recognized form or species. It was obtained from the Horsefly river, and it is quite possible that it may be identical with one of the more recently obtained specimens from the same locality, but of this no definite conclusion can be stated, and for the present the first designation must be retained.

Acer grossedentatum, Heer.

Bib : Geol. Surv. Can., 1875-76, 259-260.

In 1875 Sir William Dawson recorded the occurrence at Quesnel of a maple leaf which he regarded as identical with Heer's *A. grossedentatum*, a species also common to the European Tertiary.

Acer trilobatum productum, Heer.

Bib: Ter. Fl., VII., 261, pl. LXV, f. 10, 11: Foss. Fl. of Alaska, U. S. Nat. Mus., XVII, 227: Fl. Tert. Helv.

One incomplete specimen of a leaf from the Horsefly river appears to be indentical with *Acer trilobatum productum* of Heer, originally obtained by Lesquereux from the Tertiary of Carbon, Wyoming. This species has not been recorded by any previous observers for any part of Canada, but it is a form which occurs at Herendeen bay, Alaska, and it is a well known form in the Tertiary of Europe as first determined by Heer.

Acerites negundifolium, Dn.

Bib: Trans. R.S.C., VIII, 1890, iv, 75.

Fragments of leaves of a somewhat problematical nature were obtained from Stump lake in 1890 and referred by Sir William Dawson to *Acerites negundifolium.* They are not represented in any of the later collections and, so far as the writer is aware, they do not seem to be represented in any of the collections from other localities, either in Canada or the United States.

Æsculophyllum hastingsense, Dn.

Bib: Trans. R.S.C., I, 1895, iv, 137-161.

Fragments of leaves, evidently of the character of *Æsculus*, were obtained from Burrard inlet and described by Sir William Dawson in 1895, under the above name. As they have not reappeared in any of the Tertiary collections of later date it is impossible to add anything to the original and very meagre account.

Æsculus sp.

Bib : Trans. R.S.C., IV, 1886, iv, 29, pl. II, f. 16.

Lambe's collection from the Tulameen river in 1906 included a few very doubtful remains which seemed to represent portions of a fruit with a hard and resisting shell. The only comparison that seemed at all promising was with fruits of the horse chestnut, and this seemed the more likely to be correct because of their somewhat striking resemblance to

fruits of this character described by Sir William Dawson in 1886, and included in material from the Lignite Tertiary of Porcupine creek and Great valley.

Æsculus antiquus, Dn.

Bib: Trans. R.S.C., IV, 1886, iv, 29, pl. II, f. 16.

In 1886 Sir William Dawson described certain poorly defined remains of what seemed to be a fruit with a hard and resisting shell, under the name of *Æsculus antiquus.* These specimens were obtained from the Upper Laramie or Lignite Tertiary of Porcupine creek and Great valley, Saskatchewan. Since that time there has been nothing of a similar character in any of the Tertiary collections, unless we except the apparently nutlike remains described under the previous heading.

Ailanthophyllum incertum, Dn.

Bib : Trans. R.S.C., VIII, 1890, iv, 75-91.

From the Tranquille river in 1890 there were obtained certain leaf fragments which Sir William Dawson referred to *Ailanthophyllum incertum*, but failure to identify them in any other collections makes them of very limited value, although they suggest possible extensions of the flora, which should be kept in mind with reference to future explorations.

Alnites curta, Dn.

Bib: Trans. R.S.C., VIII, 1890, iv, 86; VIII, 1902, IV, 68.

This species was originally described by Sir William Dawson on the basis of leaves and cones derived from the Tertiary formation of the Tulameen river in 1890. More recently the same species has been noted by Penhallow in the Tertiary of the Horsefly river, while Sir William Dawson recognized two fine cones and one leaf in collections from Quilchena, made by Ells and Johnston in 1889.

In the more recent collections of Lambe, what is undoubtedly the same species is represented by several cones in various states of preservation. All of these specimens were obtained from Quilchena. From the evidence at hand, therefore, it would seem that this must have been a very common species in Tertiary times, and although it has been found in comparatively few localities, yet the relations of those localities would seem to suggest that the shrub must have had a somewhat widespread distribution, and no doubt it will eventually be found to have extended over the entire Tertiary area.

Alnites grandifolia, Newb.

Bib: Newberry, Lat. Ex. Fl. XXXV, 67, pl. LIV, f. 2: Lesquereux, Cret. and Tert. Fl., 1878, Pl. IV, f. 2: Penhallow, Trans. R. S. C., VIII, 1902, iv. 46.

This species was originally recorded by Newberry from the Dakota group of Nebraska, and later Lesquereux also obtained it from the Cretaceous of Smoky hill, Kansas. In 1902, Penhallow recognized in material from the Red Deer river of Canada, fragments of leaves which he regarded as the same. No further occurrence of this species has been recorded, and the indication of horizon which it gives must be regarded as having no precise significance, since it is a species which appears to have had a very wide range in geological time.

Alnus sp.

Fragments of leaves in a very poor state of preservation, found in the collections from Quilchena, apparently represent young leaves of a species of alder which cannot be definitely correlated with any recognized type, because of their very fragmentary condition and wholly unsatisfactory character.

Alnus alaskana, Newb.

Bib: Later Ex. Fl. XXXV, 65, pl. XLVIII, f. 8: Proc. U. S. Nat. Mus., V, 1882, 509: Cat. Cret. and Tert. Pl. 30.

Leaves of this species are found among the plants obtained by Lambe from the Tulameen river in 1906, and although in most cases imperfect and very fragmentary, one leaf showed the entire base with petiole.

This species was founded by Newberry, upon material derived from the Kootznahoo archipelago, Alaska, in latitude 57° 35′ N., and longitude 134° 19′ W. The horizon assigned by Newberry is Miocene, but Knowlton suggests a possible Eocene age.

Alnus carpinoides, Lesq.

Bib: Cret. and Tert. Fl. VIII, 243, pl. L. f. 11.

Leaves of this species, in a somewhat imperfect condition but otherwise well characterized, were found by Lambe in the beds of the Tranquille river, and also in the Horsefly river.

As originally described by Lesquereux, this species was obtained from the Miocene formation at Bridge Creek, Oregon. So far as our present knowledge goes, it does not appear to be either abundant or a widely distributed species, while its close resemblance to *Carpinus grandis*, and its evident relation to *Alnus macrophylla*, as already commented upon by Lesquereux, invest its determination with a certain element of doubt whenever imperfect specimens are to be dealt with, which goes far to impair its value for stratigraphical purposes. It is not unlikely that the specimens so described may be nothing more than badly preserved fragments of one of the species referred to.

Alnus serrulata fossilis, Newb.

Bib: Lat. Ex. Fl. XXXV, 66, pl. XLVI, f. 6.

In Lambe's collection from Quilchena there were three nearly complete specimens of leaves directly referable to *Alnus serrulata fossilis* of Newberry who had already observed this species in the Miocene of the western part of the United States.

Amygdalus gracilis, Lesq.

Bib: Cret. and Tert. Fl., VIII, 199, pl. XL, f. 12-15 and XLIV, f. 6.

In the Quilchena collection of 1906, there were two imperfect specimens of leaves which may be referred with assurance to Lesquereux's *Amygdalus gracilis*. The type is evidently not an abundant one, since it has not occurred in any other Canadian locality, but Lesquereux records its occurrence in the Green River group of Florissant, Colorado, and also in Uinta county, Wyoming.

Andromeda delicatula, Lesq.

Bib : Cret. and Tert. Fl., VIII, 175, pl. XXXIV, f. 10, 11.

This species was obtained by Lambe from the Tranquille river, and is represented in his collection by two very good specimens. The original description of this plant by Lesquereux was based upon material derived from the Green River group of Uinta county, Wyoming. Like the last, this species is distinguished by its sparing occurrence and its restriction to only two localities.

Antholithes sp.

These seed-like bodies of uncertain character have been found by Sir William Dawson among plants from the Similkameen river, but apart from the general statement that they may be seeds of some of the associated plants, it is impossible to define their character more in detail, and they are of no real value for stratigraphical purposes.

Antholithes amissus, Heer.

Bib : Trans. R.S.C., VII, 1889, iv, 69 : Flor. Foss. Arct., I, 1868, 139.

Sir William Dawson refers to this very uncertain, seed-like body as among the specimens known to the Lignite Tertiary of Mackenzie river. The original description by Heer is contained in his account of plants from the Mackenzie river, and shows a small, rounded seed-like fruit about 4 mm. broad, with a somewhat truncated base.

Aralia acerifolia, Lesq.

Bib : Cret. and Tert. Fl., VIII, 265, pl. XLV, B, f. 1.

The Quilchena material of 1906 supplied a very limited amount of this species as represented by two impressions of one leaf. This is the first record of its occurrence in Canadian Tertiary beds, but Lesquereux had already recognized it in the Fort Union group of the Bad Lands of Dakota, as well as at Chalk bluff, California, where the formation is regarded as Old Pliocene or Miocene It is evidently a species of very limited distribution, and it is possible that its very sparing representation in Canada may be due to a more southern range.

Aralia notata? Lesq.

Bib : Trans. R.S.C., VIII, 1902, iv, 68 : Tert. Fl., 237 : Proc. U.S. Nat. Mus., 1888, 40.

In the Tulameen collection of 1906, *Aralia notata*, Lesq , was represented by one imperfect fragment of a small leaf, in consequence of which the present determination is regarded with some hesitation. What appears to be the same leaf, however, reappears in the collections from Quilchena, made in the same year, and in 1894 it was obtained from the Horsefly river by Dr. G. M. Dawson. Lesquereux's determination was based upon material derived from the Eocene? of Mt. Brosse, Colorado; Elk creek, Yellowstone river, Montana and Yellow creek, California.

Arundo sp.

Bib : Geol. Surv. Can., VIII, 1894, 36, 37 C.

During the progress of his survey work in British Columbia, in 1904, Dr. G. M. Dawson obtained from the Tertiary of the Omineca river a small specimen of a monocotyledonous leaf which Sir William Dawson referred to the genus *Arundo* but without being able to designate it specifically.

Asplenites sp.

Fragments of a fern with the general aspect of *Asplenium* were referred to *Asplenites* by Sir William Dawson in 1895. They were found in material obtained from Burrard inlet, British Columbia, where the formation is regarded as of Eocene age.

Azollophyllum primævum, Penh.

Bib: Trans. R. S. C., VIII, 1890, iv, 75-91.

There is only one record of this form, the details of which, though very imperfectly defined, strongly suggest a plant of the type of *Azolla*. The name given is altogether provisional. The single specimen upon which the name was founded was derived from Stump lake in 1890.

Betula sp.

Bib: Trans, R. S. C., VIII, iv, 75-91; and XIII, 1907.

Several of the collections of Tertiary plants have shown, from time to time, more or less numerous impressions of cones which are clearly referable to the genus *Betula*. Some of these were recorded by Sir William Dawson from the Similkameen river in 1890. More recently they have appeared in the collections of Dr. R. A. Daly from the Kettle river; and in the collections of Lambe in 1906, they have been found at both the Tranquille and the Tulameen rivers.

In most cases the cones are badly crushed and the details are often obscure. It is therefore difficult to say if there is more than one species, nor is it possible to correlate these remains with any of the forms recognized through the leaves. It may be recalled, however, that no less than four species of birch are represented by their leaves in the same localities from which the cones were obtained.

Betula angustifolia, Newb.

Bib: Lat. Ex. Fl. XXXV, 63, pl. XLVI, & XLVII, f. 5: Proc. U. S. Nat. Mus., V., 1882 508.

The only Canadian record for this species is to be found in the collections of Ells and Johnston from Quilchena in 1904. Newberry originally obtained specimens from Bridge Creek, Oregon, in a formation regarded as Miocene.

Betula heterodonta, Newb.

Bib: Proc. U. S. Nat. Mus., V, 1882, 509: Lat. Ex. Fl., XXXV, 64, pl. XLIV, 1-4.

This somewhat well characterized species was represented by a single specimen of a leaf from the Tranquille river, in the collections of 1906, but it had previously been observed in the collections from Quilchena, which also included a fruit, possibly of the same species.

The species was originally founded by Newberry on the basis of specimens from Bridge creek, Oregon. The formation of this locality is supposed to be Miocene, which view would be in accord with the probable age of the Quilchena beds.

Betula macrophylla, Goepp.

Bib: Fl. Foss. Arct., VI., pl. II, f. 3-5, p. 14.

In the collection of Lambe from the Tranquille river there were found several large and well characterized fragments of leaves showing the base venation and margin in a very

satisfactory manner, and it was possible to refer them to *Betula macrophylla* without hesitation. Together with the leaves there were also a number of cones of birch which, from their intimate association with the leaves, were believed to be of the same species. The largest measured 28 mm. long and 8 mm. wide. It is quite probable that some of the cones previously discussed may belong here.

The only other record of this species for Canadian localities is to be found in Heer's report upon the plants collected by Sir John Richardson in the Mackenzie River basin in 1856. No record is to be found for localities in the United States, from which it may be inferred that this primarily European type is found in America only in somewhat high latitudes.

Betula prisca ? Ett.

Bib: Geol. Surv. Can., 1875–76: U. S. Geol. Surv., Bull. 37, 1887, 31, pl. XIV., f. 2: Fl. Foss. Alask. 28, pl. V. f. 3–6.

Specimens of a birch derived from the Quesnel river in 1874 were regarded by Sir William Dawson as possibly belonging to *Betula prisca*, Ett. This species has been recorded by Ward as occurring in the Fort Union group at Seven-mile creek, Montana, while Heer has noted it in the Eocene of Alaska at Port Graham and Neniltschik.

Betula stevensoni, Lesq.

Bib: Trans. R.S.C., VIII, 1890, iv, 89, f. 30: Ter. Fl. VII, 138: Cat. Cret. and Tert. pl. 48: Geol. Surv. Can., 1877–78, 186 B: Trans. R.S.C., VIII, 1902, iv, 68.

Very fragmentary leaves from the Similkameen river, found in Lambe's collection of 1906, are undoubtedly the same as the imperfect specimens figured by Sir William Dawson in 1890, and also derived from the same locality. These specimens were recognized as *B. geopperti*, the original description of which by Lesquereux was based upon specimens from Evanston, Wyoming. More recently *B. goepperti* has been found by Knowlton to be identical with *B. stevensoni*, Lesq., and it has been so transferred. It is therefore possible to extend the range of this species by including specimens from Nine-mile creek, Similkameen river, described by Sir William Dawson in 1877, and from the Horsefly river as described by Penhallow in 1902.

Callistemophyllum latum, Dn.

Bib: Geol. Surv. Can., 1888–89: Trans., R.S.C., VII, 1889: Flor. Dak. Gr. 138.

There is only one record of the occurrence of a leaf which Sir William Dawson referred to the above genus and species, although with some hesitation. The specimen was derived from the Tertiary of the Mackenzie River basin, a formation generally regarded as of Miocene age. It may be noted in this connexion that the only other record of the genus in America is contained in Lesquereux's recognition of *C. heerii*, Ett., in the Dakota group of Kansas.

Carex burrardiana, Dn.

Bib: Trans. R. S. C., I, 1895. 137–161.

The only example of this species is to be found in a collection from Burrard inlet, described by Sir William Dawson in 1895. The specimen consists of a spike which has been compressed longitudinally so that, looking from above, it presents the aspect of a whorl of bracts.

Carex vancouverensis, Dn.

Bib: Trans. R. S. C., I, 1895, 137, 161.

This species is also represented by a single specimen from Burrard inlet, and was first described by Sir William Dawson in 1895. It consists of a single spike of which about half of the length is preserved, showing three rows of grains. Neither this nor the preceding has been found in any other locality.

Carex sp.

In the collections from the Horsefly river, as also in those from Quilchena, there were several small, seed-like bodies which have the general aspect of Cyperaceous fruits. In one instance the body had a distinctly triangular form and its approximation to the seed of a *Carex* seemed very close. In general, the preservation of these bodies was so imperfect as to make a complete determination impossible, and all that can be done at present is to make a provisional reference to the genus *Carex*.

Carpinus grandis, Ung.

Bib: Geol. Surv. Can., 1877-78: Trans. R. S. C., VIII, 1890, iv, 87: Cret. and Tert. Fl. VIII, 152; Tert. Fl. VII, 1878, 143: Lat. Ex. Fl. XXXV, 59, pl. LIV, f. 3: Cat. Cret. and Tert. Pl. 54: Fl. Foss. Arct., I, 103: Fl. Tert. Helv., I, 40; II, 40, pl, LXXI, f. 19; LXXII, f. 2-24; LXXIII, f. 2-4: Fl. Foss. Alaska, 29, pl. II, f. 12.

One of the most abundant and best characterized species from the Tertiary of British Columbia is represented by *Carpinus grandis*, Ung. In the collections of Lambe it appears among the specimens from the Tulameen, the Tranquille and the Similkameen rivers as also from Quilchena. The proportion of specimens relatively to the entire collection was in most cases much larger than for any other species except some of the *Sequoias* and *Taxodium*, from which we may infer that it was not only an abundant type, but that it was essentially common to the entire Tertiary area. This latter inference is also justified by the fact that it has appeared in previous collections from other localities, with great frequency, and indeed it has formed one of the constantly recurring species of almost every collection. Thus, in 1904, Ells and Johnston obtained it from Quilchena; in 1877 and again in 1890 it was recorded from the Similkameen river; and in 1890 it was once more recorded by Sir William Dawson from Stump lake.

Within the limits of the United States, Lesquereux has noted its occurrence in the Green River group of Colorado and at Elko station, Nevada, while Newberry directs attention to its occurrence at the mouth of the Fraser river and at Birch bay, Washington. It is also an element of the flora of the John Day basin, Oregon, of Cook inlet, Alaska, and probably, of Brandon, Vermont.

Heer has shown it to be a feature of the Miocene flora of northern Greenland, as well as of the Tertiary of Europe. In Alaska it is found at Kachemak bay and Port Graham.

Carpolithes sp.

Bib: Geol. Surv. Can., 1888-89: Trans. R. S. C., IV, 1886, iv, 19-34; VII, 1889.

In the collection from Quilchena there were three small fruits of an undeterminable character which may be referred to *Carpolithes*. Somewhat similar bodies were noted by Sir Wlliam Dawson in collections from the Mackenzie river in 1888, and they had also

been recognized on a previous occasion in the flora of the Lignite Tertiary of Porcupine creek and Great valley, Saskatchewan.

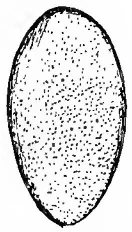

FIG. 5. *Carpolithes* sp.
Tulameen River. x 5.

Carpolithes sp.

In Lambe's collection of 1906, from Red point, Kamloops lake, near the Tranquille river, there was a single specimen of a very small fruit, possibly of a willow, which answers to the following description and figure 6:—

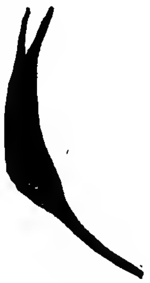

FIG. 6. *Carpolithes* sp.
Tranquille River. x 5.

Fruit 8 mm. long, 1.25 mm. wide; narrow, fusiform, curved; with a slender stalk nearly as long as the body; two cleft at the somewhat prolonged summit.

Carpolithes dentatus, Penh.

Bib: Trans. R. S. C., VIII, 1890, iv, 89, f. 26.

In 1890, Sir William Dawson published under the name of *Carpolithes dentatus*, Penh., an account of a winged fruit from Stump lake, the nature of which could not be determined. But little information concerning it could be obtained at that time, and it remained an altogether unique specimen until the collections of Lambe showed it to be a common form in several localities. In the material from the Horsefly river there were three specimens which were readily identified with the original; the Tranquille river furnished two or three specimens and Quilchena supplied two. These last were 2 mm. wide and 3 mm. long. In all of these specimens the seed was surrounded by a net-veined wing with a dentate margin, but invariably more or less broken. It has not yet been possible to establish connexion with any of the associated leaves, but a very careful comparison of fruits of this type leads to the conclusion that it may represent a *Carpinus*. This view is somewhat strengthened by the very general association of leaves of *Carpinus grandis* to which the fruits may belong. In the absence of any conclusive evidence to this effect, however, the present name should be retained.

Carpolithes seminulum, Heer.

Bib : Trans. R.S.C., VII, 1889, iv, 69 : Flor. Foss. Arct., I, 1868, 139.

The original account of this very small, seed-like body was given by Heer in his study of Tertiary plants from the Mackenzie river. It is oblong in form and measures 2 x 3. 5 mm. Dawson refers to the occurrence of this form in a later account of the Lignite Tertiary plants, but without comment.

Carya sp.

Bib : Geol. Surv. Can., 1875-76.

A nut obtained from Quesnel river in 1875 was regarded by Sir William Dawson as belonging to the genus *Carya*.

Carya antiquorum, Newb.

Bib : Trans. R.S.C., IV, 1886, iv, 19-34 ; VIII, 1902, iv, 46 : Lat. Ex. Fl., XXXV, 35 : Cret. and Tert. Fl., VIII, 236 : Tert. Fl., VII, 289.

The history of this familiar Tertiary species shows that it was first observed in Canadian limits in 1886, in the Lignite Tertiary of Porcupine creek. In 1897, collections by Lambe from the Red Deer river, at the mouth of the Blindman, were found to include it. In 1902 it was recorded by Penhallow from the Horsefly river, and in 1904 it was once more brought to notice in the collections of Ells and Johnston from Quilchena.

The collections of Lambe in 1906 gave further evidence of its occurrence in the Horsefly river and at Quilchena, and extended the area of distribution to the Tranquille river. In these instances, as in most former collections, the leaves are represented by fragments only, but the distinguishing features are usually so well defined as to leave little room for question as to their identity.

According to Newberry, this species is a constituent of the Eocene flora at the mouth of the Yellowstone river, Montana, and Lesquereux records it from the Miocene of the Bad Lands in the Yellowstone valley, as well as from Evanston, Wyoming, where it is found in abundance.

The evidence of all observers seems to indicate that while this species is found in the Lignite Tertiary, it is apparently more abundant in and more characteristic of the Miocene.

Castanea sp.

Bib : Trans. R.S.C., IV, 1886, iv, 19-34 : Geol. Surv. Can., 1879-80.

A fragment of a leaf from the Lignite Tertiary of Porcupine creek was referred to *Castanea* by Sir William Dawson in 1886, but it seems not improbable that it may more properly belong to a species of *Quercus* not specifically described, but recorded by Sir William Dawson in 1879.

Castanea castaneæfolia, (Ung.) Knowlton.

Bib : Cat. Cret. and Tret. Pl., 1898 : Geol. Surv. Can., 1875-76 : Trans. R.S.C., VIII, iv, 68, 1902 : Cret. and Tert. Fl., 1883, 246 : Foss. Fl. Alaska, Knowlton, 1904, 218.

In 1898, Knowlton determined the essential identity of *Fagus castaneæfolia*, Unger, with *Castanea ungeri*, Heer, and thus combiued these hitherto distinctive names in the designation *Castanea castaneæfolia* (Ung.) Knowlton.

This somewhat well characterized species was first observed in Canada by Sir William Dawson in 1875, in collections from both the Blackwater and the Quesnel rivers. Dawson then expressed the opinion that it was allied to the North Americau species *C. pumila*. In 1902 it was agaiu recognized by Penhallow in collections from the Horsefly river, but it has not been seen in any of the subsequent collections. It is, however, a well known species in the United States where it is found in the Miocene of John Day valley, Oregon, and Corral Hollow, California, as well as in the Eocene of Cherry creek, Oregon. In Alaska it occurs at Port Graham.

Castanea intermedia ? Lesq.

Bib: Tert. Fl. VII, 164, pl. XXI, f. 7: Cret. and Tert. Fl., VIII, 156.

The only representation of this species was found in a small fragment showing the margin of a leaf and a small part of the venation. Some doubt attaches to the identification because of the close resemblance to *Quercus consimilis*, which it may be. The specimen was found in the collection from Quilchena, made by Lambe in 1906. Lesquereux's determinations show it to occur in the Green River group of Middle park, Colorado, and Randolph county, Wyoming.

Catalpa crassifolia, Newb.

Bib: Lat. Ex. Fl., XXXV, 1868, 56: Geol. Surv. Can., 1887: Trans. R.S.C., IV, 1886, iv, 19-34.

Since Newberry's recognition of this rather rare species, in the Fort Union group of Montana, it has been recognized by Sir William Dawson in the Tertiary of the Red Deer river, and in the Lignite Tertiary of Porcupine creek and adjacent localities. There is no record of its occurrence since that time.

Ceanothus sp.

Bib: Trans. R.S.C., VIII, 1890, iv, 75–91.

The only record for this undescribed species of *Ceanothus* is to be found in the account by Sir William Dawson who derived his specimen from the Tulameen river in 1890, and from deposits supposed to be of lower Miocene or Oligocene age. Only two other records for American localities bave been made for the genus. These are *C. meigsii*, Lesq., from the eolignitic of Mississippi and Lagrange, Tennessee; and *C. cretaceus*, Dn., from the Upper Cretaceous of Port McNeill, Vancouver island, with neither of which is there a possible correlation.

Cercis parvifolia, Lesq.

Bib: Trans. R.S.C., VIII. 1890, iv, 46: Cret. and Tert. Fl., 1883, 201.

The recognition of *Cercis parvifolia* in the Tertiary beds of Red Deer river in 1902 constituted the first observation of this species since Lesquereux obtained it from the Green

River group of Florissant, Colorado, in 1883. Since that time it has not appeared in any of the collections with which I am familiar. The genus is nevertheless represented by three other species belonging to the Fort Union group.

Cinnamomum affine, Lesq.

Bib: Trans. R.S.C., VIII, 1890, iv, 75–91: Tert. Fl., VII, 219, pl. XXXVIII, f. 1–5. 7: Cret. and Tert. Fl., VIII, 252, pl. LVIII, f. 9.

Cinnamomum affine was first recognized in the Canadian Tertiary by Sir William Dawson in 1890, in material derived from the Tulameen river, but it has not appeared in any subsequent collections until 1906, when Lambe obtained it from three separate localities. From the Tulameen river he got three specimens of leaves showing characteristic venation, although not complete. From the Tranquille river he collected several well characterized specimens, but they were all fragmentary and showed only the tips and bases. From the Horsefly river, three very good specimens were obtained, and also one from the mouth of Whipsaw creek.

Reference to Lesquereux's figures and descriptions shows that the Canadian specimens are identical with his. This species has been obtained from the Miocene of Corral Hollow, California; the Montana group of Coalville, Utah; the Denver beds of South park, Colorado and Laramie group of Colorado, Wyoming and New Mexico.

The genus is represented in the United States by sixteen species, the distribution of which ranges from the middle Cretaceous to the Miocene.

Clintonia oblongifolia, Penh.

Bib: Trans. R.S.C., VIII, 1902, iv., 56.

The species given here was based upon a single leaf contained in a collection from the Red Deer river, made by Lambe in 1897. It has not been observed in any other collection.

Comptonia diforme, (*Sternb.*) Berry.

Bib: Trans. R.S.C., VIII, 1890, iv, 81, f. 10: Amer. Nat., XL, 1906, 519.

This very well characterized form was originally published by Sir William Dawson in 1890 as *C. columbiana*, but the most recent revision of the genus by Berry indentifies it with *C. diforme* of Sternberg, to which it is transferred.

Dawson's descriptions were based upon specimens from Kamloops lake and from the Tulameen river. He refers to the resemblance which *C. diforme* bears to Saporta's *Myrica* (*C*) *matheroniana* from the Oligocene of Armissen, and to Lesquereux's *Myrica partita* from the Green River group of Nevada.[1] He further adds that its range "extends from the Upper Cretaceous to the Miocene where it meets forms like *Myrica asplenifolia*, and there is presumptive evidence that it indicates Miocene or at least Oligocene age."

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[1] Berry considers that there is no resemblance to *C. matheroniana*, but does agree as to the resemblance to *C. partita*, and to some extent a connexion with *Comptoniophyllum japonicum* of Nathorst.

The more recent collections of Lambe, made in 1906, give fresh evidence of its occurrence in the Similkameen valley, and they extend the range to the Tulameen river. No other localities for North America have been reported, but the species is common to the Tertiary of Europe.

Comptonia dryandroides, Ung.

Bib: Trans. R.S.C., VIII, 1890, iv, 80: Proc. U.S. Nat. Mus., V, 445: Amer. Nat. XL, 1906, 502.

This species was originally founded by Unger on the basis of specimens from the Miocene of Europe. In 1882, Lesquereux described certain specimens from Coal harbour, Unga island, Alaska, under the name of *Myrica cuspidata.* This has been shown more recently to be identical with Unger's species, to which it has been transferred by Berry.

In 1890, Sir William Dawson obtained specimens of this plant from the Miocene of the Similkameen and recognized its resemblance to *C. dryandroides* of Unger, though retaining the original name. He also considered *C. obtusiloba* and *C. œningensis* from the Miocene of Europe as its representatives there.

In the more recent collections of 1906, by Lambe, it once more appears in the Tertiary of the Similkameen river, and also at Quilchena.

Comptonia partita (Lesq.) Berry.

Bib: Geol. Surv. Can., 1877-78: Amer. Nat., XL, 1906, 512: U.S. Geol. Surv. Terr., 1873, 412: Tert. Fl., 1878, 134.

Originally derived from the Green River group at Elko station, Nevada, it was later obtained from Vermilion cliff on the Tulameen river, and described by Sir William Dawson in 1877. Lesquereux first described it under the name of *Myrica partita*, but in his recent revision of the genus *Comptonia*, Berry has transferred it to that genus. It appears to be a rare form, although Berry inclines to the view that *C. columbiana*, of Dawson, is very closely related.

Comptonia quilchenensis n. sp.

A single example of a badly preserved and much broken leaf was found in the collection from Quilchena in 1906. From its general appearance (fig. 13), it is probably to be regarded as a species of *Comptonia*, to which the provisional name *C. quilchenensis* is given. The character of the specimen does not admit of a precise specific description.

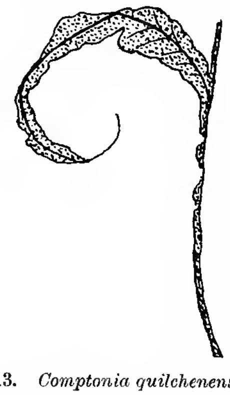

FIG. 13. *Comptonia quilchenensis* n. sp.
A much broken leaf from Quilchena. x 2.

Cornus newberryi, Hollick.

Bib: Lat. Ex. Fl., XXXV, 124, pl. XXXVII, f. 2-4.

The only Canadian record of this species is found in a specimen from Quilchena, obtained by Ells and Johnston in 1904. There is also only one record for the United States as contained in the original description given by Newberry under the name of *Cornus acuminata.* Hollick has noted the previous occupation of this name by O. Weber, in consequence of which he has substituted the name *C. newberryi* as given.

Cornus suborbifera ? Lesq.

Bib: Fl. Tert. Helv., III, 27, pl. CV, f. 15-17: Cat. Cret. and Tert. Pl., 76: Cret. and Tert. Fl., 262: Proc. U.S. Nat. Mus., V, 1882, 448: Tert. Fl. 243.

In Lambe's collection from the Tulameen river there were two imperfect specimens of a leaf, of which one was about two-thirds complete, representing what seemed to be *Cornus suborbifera*, Lesq. A similar but less perfect specimen was obtained from Quilchena. So far as it is possible to determine, however, all of these specimens appear to answer fully to the characters presented by Heer's *C. orbifera* from the Tertiary of Europe, a species which Knowlton identifies with and transfers to *Cornus suborbifera* of Lesquereux.

Lesquereux has recorded this species from Cook inlet, Alaska, and from the Laramie formation of Golden, Colorado.

Cornus rhamnifolia, O. Web.

Bib: Trans. R. S. C., VIII, 1902, iv, 46: U. S. Geol. Surv. Terr., 1871, 9: Tert. Fl. 244, pl. LXII, f. 6.

Collections from the Red Deer river, in 1889, contained a few representatives of *Cornus rhamnifolia.* It was previously unknown in Canada, nor has it appeared in any collections since then. It has, however, been reported by Lesquereux from the Laramie formation of Bozeman, Montana, and from the Montana formation at Point of Rocks, Wyoming.

Corylus sp.

Bib: Geol. Surv. Can., 1877-78, 186 B.

An undetermined species of *Corylus* was obtained from Nine-mile creek, Tulameen river and described by Sir William Dawson in 1877.

Corylus americana, Walt.

Bib: Trans. R. S. C., VIII, 1902, iv, 58: Lat. Ex. Fl. XXXV, 60, pl. XXIX, f. 10.

Our first knowledge of the occurrence of *Corylus americana* in the Canadian Tertiary was based upon a single specimen derived from the Red Deer river in 1899. Since then the collections of Lambe, in 1906, have very materially extended our knowledge of its geographical range. Several fragments with one nearly perfect leaf were obtained from the Tranquille river; two specimens from Quilchena and one very incomplete fragment from the Horsefly river. Although apparently common to the entire Tertiary area of British Columbia, the very meagre specimens lead to the inference that it is not an abundant species.

It has been recorded by Newberry from the Fort Union group of Seven-mile creek, Montana, and Fort Union, Dakota. It is also known to the Laramie of Porcupine creek, Saskatchewan.

Corylus macquarrii, (Forbes) Heer.

Bib: Trans. R. S. C., VIII, 1902, iv, 46; IV, 1886, iv, 19-34: Geol. Surv. Can., 1887: Fl. Foss. Alask., 33, pl. II, f. 9; IV, f. 1-5, 8.

This exceedingly well characterized leaf was obtained by Lambe from the Horsefly river in 1906. In 1897 he also obtained specimens from the Red Deer river, at the mouth of the Blindman, from which locality it had been reported by Sir William Dawson in 1887. In 1886 it was reported from the Lignite Tertiary of Porcupine creek and Great valley. Heer refers to it as a common species in the Tertiary of various parts of Alaska, while Lesquereux shows that it is abundant in the United States, where it may be found in the Fort Union group of Montana, and in the Laramie of Carbon, Wyoming.

Corylus rostrata, Ait.

Bib: Lat. Ex. Fl. 1868, 60: Trans. R. S. C., IV, 1886, iv, 19-34.

First recognized by Newberry in the Fort Union group at Seven-mile creek, Montana, and at Fort Union, Dakota, *Corylus rostrata* was later ascertained by Dawson to be a constituent of the Lignite Tertiary flora at Porcupine creek and Great valley, Saskatchewan.

Cratægus tulameenensis n. sp.

In Lambe's collection from the Tulameen river there was found a single specimen of a beautifully preserved fruit consisting of several hard seeds enclosed in a firm flesh. The latter had been crushed off in such a manner as to expose three seeds, together with evidence that others were present but hidden. In addition to an obvious stem the opposite extremity showed at least one calyx tooth, justifying the conclusion that the fruit had been derived from an inferior ovary. These structural features, joined to the dimensions of the specimen, seemed to indicate that the fruit was that of a haw or *Cratægus*. It is represented by figure 7, and conforms to the following description:—

FIG. 7. *Cratægus tulameenensis* n. sp.
Fruit showing seeds and remains of calyx.
Tulameen River. x 1/1.

Fruit ovid, 13 cm. broad, 14 cm. long with a narrow beak formed from a persistent calyx lobe; stem 1.5 mm. wide, 3 cm. long; seeds three, enclosed in a fleshy pericarp which has been crushed off at one side of the base.

No similar fruit has been found in any collection from the Canadian Tertiary, nor is it comparable with any fruit from the same formation in Europe or the United States, and it is therefore necessary to distingush it by a new name, for which that of the locality seems appropriate.

Cratægus tranquillensis n. sp.

In collections from the Tranquille river, as also from the Horsefly, single specimens of a leaf were found. These were directly comparable with recent forms of leaves of more than one species of *Cratægus* to which they undoubtedly belong. They are represented by figure 8 and answer to the following description :—

FIG. 8. *Cratægus tranquillensis* n. sp.
Leaf from the Horsefly River. x 1/1.

Leaf short-petioled ; 35 mm. long, 32 mm. wide, broadly obovate with a somewhat wedge shaped base; veins strongly defined; margin rather finely and irregularly dentate; apex broad, rounded, in the specimen somewhat emarginate by breakage.

Several species of *Cratægus* are known in the United States, but with one exception they are all Cretaceous. There is no record of the genus in Canada other than the one now made. Had the fruit and leaves occurred in the same beds, there would have been little reason for regarding them as distinct species, but their isolation in somewhat widely separated beds makes such a conclusion unsafe.

Cupressoxylon sp.

In the report of the Geological Survey of Canada for 1873-74, Dr. G. M. Dawson records the occurrence in the Edmonton coal beds of specimens of wood which he refers to the genus

Cupressoxylon. As no details of microscopical examination are given, it is not possible to refer it to any one of the various species known to the Tertiary.

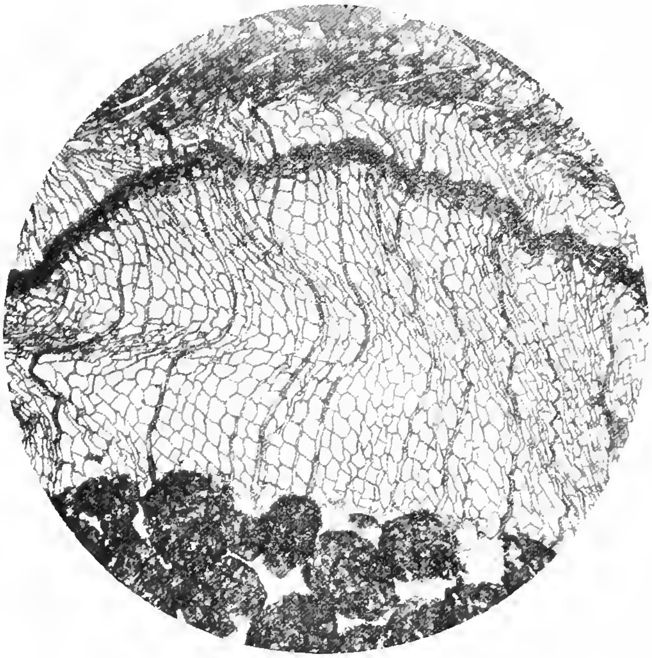

FIG. 9. *Cupressoxylon dawsoni*, Penh.
Transverse section. x 52.

Cupressoxylon dawsoni, Penh.

Bib : Trans. R.S.C., IX, 1903, iv, 33 ; X, 1904, iv, 60.

The first recognition of the wood of this species was made in 1903 through the examination of material derived from the Lignite Tertiary of Porcupine creek and Great valley. It was later observed in the Cretaceous formation at Medicine Hat, Saskatchewan. In the

collections of Lambe from the Horsefly river, in 1906, there were several specimens of wood, one of which proved to be indentical with this species.

Fig. 10. *Cupressoxylon dawsoni*, Penh.
Tangential section. x 52.

Cupressoxylon macrocarpoides, Penh.

Bib: Trans. R.S.C., XIII, 1907, iv.

The original description of this wood was based upon material from the Cretaceous deposits of the South Saskatchewan, near Medicine Hat, Saskatchewan, in 1904. Since then it has been recognized in the Kettle River deposits of British Columbia, from which it was obtained by Dr. R. A. Daly in 1905.

Cyperites sp.

This widely distributed and very common type of stems and leaves offers little or nothing of value in the determination of stratigraphical relations, or in the solution of biologi cal problems, since its relegation to the genus *Cyperus* is based on a very broad resemblance to the external aspect of the leaves and stems of those plants. It will be sufficient to point out that such remains are common to almost all Tertiary collections, and in the present instance they are found in material from the Tulameen, the Horsefly, the Similkameen, the Tranquille and the Kettle rivers, as well as from Quilchena. In fact they may be regarded as features of the entire Tertiary flora of British Columbia and the western portions of Canada.

Cyperites haydenii, Lesq.

Bib : Trans. R. S. C., XIII, 1907, iv : Cret. and Tert. Fl., 1883, 140.

The only Canadian locality for this species is the Kettle river, B.C., from which specimens were obtained by Dr. R. A. Daly in 1905. It was recorded by Lesquereux in 1883, from the Green River group of Uinta county, Wyoming. It is evidently a rare though widely distributed species.

Cyperites paucinervis, Heer.

Bib: Trans. R. S. C., I, 1895, iv, 137–161: Fl. Tert. Helv., I, 79, 1885.

Sir William Dawson recorded this species from Burrard inlet in 1895. There is no further knowledge of it in Canadian localities, nor has it been recorded for the United States, but it is a type which Heer has recognized in the Tertiary of Europe.

Davallia tenuifolia, Sw.

Bib: Trans. R. S. C., IV, 1886, iv, 19–34: B.N.A. Bound. Com., 1874–75, App. A. 329.

The only American record for *Davallia tenuifolia* is contained in Sir William Dawson's report on the flora of the Lignite Tertiary in the British North American Boundary Commission's report, and in a subsequent account of Laramie plants as contained in the Transactions of the Royal Society of Canada for 1886.

Diospyros alaskana ? Schimp.

Bib: Geol. Surv. Can., 1875–76.

A single leaf of this tree was obtained by Dr. G. M. Dawson from the Blackwater river in 1875. It has also been reported from the Laramie of Evanston, Wyoming, and from the Eocene? of Cherry creek, Oregon and Bellingham bay, Washington. In Alaska it is met with at Port Graham. It is likewise a European species.

Dombeyopsis islandica, Heer.

Bib: Geol. Surv. Can., 1875-76: Cat. Cret. and Tert. Fl., 1898, 90.

Only one record for this plant is found in material from Quesnel, as given by Dr. Dawson in 1875, but four species are found in the Laramie and Denver groups of the United States.

Dryophyllum stanleyanum, Dn.

Bib : Trans. R. S. C., I, 1895, iv, 147, pl. VII, 13 : Cret and Tert. Fl., VIII, 244, pl. LIII, f.8—14 ; LVI, f. 1–2: Cat. Cret. and Tert. Pl., 1898, 90.

In the Quilchena collection there was one specimen consisting of the base of a leaf which is probably identical with *Dryophyllum stanleyanum* of Dawson. Sir William Dawson, however, seemed to have some doubts as to the precise identity of his specimen, since he remarks that it bears a strong resemblance to *Quercus furcinervis*, Rossm, as described by Lesquereux from the Miocene of Bridge Creek, Oregon, although it seems distinct. And he further remarks that it may eventually prove to be a *Laurus* or a *Magnolia*. The doubts thus

expressed have not been removed by the Quilchena material which is altogether too imperfect for that purpose.

Sir William Dawson's specimen from Stanley park, Vancouver, was derived from beds of Eocene age, but four other specimens enumerated by Knowlton are from the Cretaceous.

Equisetum sp.

Bib: Trans. R. S. C., IV., 1886, iv, 19-34.

A specimen of *Equisetum* from the Lignite Tertiary of Porcupine creek and Great valley shows in one case fragments of stems and in another remains of roots and tubers. These are treated separately by Sir William Dawson although he considers there is reason to think they may be the same species.

Equisetum arcticum, Heer.

Bib: Trans. R. S. C., VIII, 1902, iv, 46; IV, 1886, iv, 22: Mioc. Fl. and Faun. of Spitzbergen, 1870, 31.

In collections from the Eocene formation of Red Deer river, obtained in 1898, there were a few specimens of *Equisetum arcticum*. What is also probably the same species was obtained from the Lignite Tertiary of Porcupine creek and Great valley and recorded by Sir William Dawson in 1886, but there is no further record of it in subsequent collections.

E. arcticum is a type common to the Miocene of Spitzbergen, and its resemblance to *E. wyomingense*, Lesq., from the Tertiary of Green River station, Wyoming, should be noted.

FIG. 11. A branch showing false dichotomy. Tranquille River. x 1 1.

Equisetum parlatorii, (Heer) Schimp.

Bib: Trans R. S. C, I, 1882-83, iv, 32 ; IV, 1886, iv 22 : British N. Amer. Bound. Comm , 1875, 329 : Flor. Tert. Helv., I, 109, Pl. XLII, f. 2-17 : Pal. Veg., I, 1869, 261 : Cat. Cret. and Tert. Plants, 1898, 95.

The first account of this species was given by Heer in 1859, who obtained it from the Miocene of Switzerland and described it under the name *Physagenia parlatorii.* But Schimper afterwards pointed out that these specimens were undoubtedly a species of *Equisetum*, a view later accepted by Dawson, and subsequently adopted generally.

The first recognition of this plant in North America was through the work of Sir William Dawson in connexion with his studies of the Lignite Tertiary formation in the neighbourhood of the 49th parallel, where he observed it in the lignite beds of Great valley.

Equisetum similkameenense, Dn.

Bib: Geol. Surv. Can., 1877-78, 186: Trans. R. S. C, VIII, 1890, iv, 76.

An *Equisetum* from the Similkameen river at Nine mile creek was described under the above name by Sir William Dawson in 1877, and recorded for the second time from the same locality in 1890. It has not appeared in any other collections.

FERN STIPES.

Various fragments of branching stems appeared in Dr. Daly's collection from Kettle river in 1905 They could not be associated with any foliage, but from their general character they were believed to represent the stipes of ferns in various stages of preservation

Fagus antipofi, Abich.

Bib: Geol. Surv. Can., 1875-76 : Fl. Foss. Alask , 30 : Cat Cret. and Tert. Pl. 1898, 98.

A few specimens of this species of beech have been recorded by Sir William Dawson from the Quesnel river. It has also been recorded by Heer from Port Graham, Alaska; from the Miocene of Table mountain, California, and from the Laramie ? formation of Point of Rocks, Wyoming.

Bib: Tert. Fl., 146.

Fagus feroniæ, Ung.

In 1875 Sir William Dawson determined the presence of *Fagus feroniæ* in the Tertiary formation of both the Quesnel and the Blackwater rivers. In Europe it is a recognized type in the Miocene formation, and in Alaska it is found at Port Graham. The only other American locality at present known is the Green River group of Elko station, Nevada.

Ficus sp.

Bib: Geol. Surv. Can., 1887: Trans. R.S.C., VIII, 1890, iv, 75-91.

Several fragments of leaves, apparently referable to the genus *Ficus*, have appeared in more than one collection in previous years, but their very fragmentary condition makes it impossible to refer them to any recognized species.

In 1887, Sir William Dawson recorded such leaves from the Red Deer river. In 1890 he recorded what appeared to be the same leaves from the Similkameen river. In 1904, Ells and Johnston obtained similar leaves from Coal gully, and they once more appear in the collections of Lambe from the Horsefly river.

Ficus asarifolia? Ett.

Bib: Tert. Fl., 207, pl. LXI, f. 18-21.

A single, imperfect leaf from the Horsefly river, collected by Lambe in 1906, probably belongs to *Ficus asarifolia.* This species is also found in the Laramie of Black buttes, Wyoming; in the Montana formation at Point of Rocks, Wyoming, and in the Denver beds at Golden, Colorado.

Ficus asiminæfolia, Lesq.

Bib: Trans. R.S.C., VIII, 1890, iv, 89: Cret. and Tert. Fl., VIII, 250, pl. LVI, f. 1-3.

In Lambe's collection from the Tulameen there were a few leaves which appeared to be identical with those figured by Sir William Dawson as *Ficus asiminæfolia.* A problematical specimen from the Tranquille river, also in Lambe's collection for 1906, presents a high degree of alteration which has left a film of iron oxide, and the identification is very doubtful; but the shape and size of the blade which is complete, together with the thick petiole, seem to suggest its relation as indicated.

The only United States locality for this species is that from which the original specimens were obtained by Lesquereux, in the Miocene beds of Rock Corral, California.

Ficus decandolleana, Heer.

Bib: Fl. Tert. Helv., II, 66, pl. C. f. 15.

In the material from Quilchena the collections of Lambe for 1906 contain two fragments of leaves which show the base and venation, and they appear to be identical with leaves of *Ficus decandolleana* of Europe as described by Heer.

Ficus occidentalis? Lesq.

Bib: Trans. R.S C., I, 1895. iv, 137-161: Tert. Fl., 1878, 200.

Fragments of a doubtful character were obtained from Stanley park, Vancouver, and were referred to this species by Sir William Dawson in 1895. The only other United States locality is that recorded by Lesquereux at Golden, Colorado.

Ficus populina, Heer.

Bib: U. S. Geol. Surv. Terr, 1871, Supp. 6: Fl. Tert. Helv., II, 66, pl. LXXXVI.

Lambe's collection of 1906 contains several well characterized fragments of *Ficus populina,* Heer. The majority of these were from the Horsefly river, but there were also several from the Tulameen. The only other United States reference to this species is to be

found in Lesquereux's account of the Tertiary deposits of Green river, Wyoming; but it is a European species which Heer originally described on the basis of material from Switzerland.

Ficus shastensis? Lesq.

Bib: Proc. U.S. Nat. Mus., XI, 28:

Lesquereux originally described this species from the Miocene of Shasta county, California; and in 1895 Sir William Dawson obtained from Burrard inlet, British Columbia, a poorly defined specimen which he referred with some hesitation to *Ficus shastensis.*

Ficus spectabilis? Lesq.

Bib: Trans. R. S. C., I, 1882--83, iv, 32: U. S. Geol. Surv. Terr., 1872, 379: Tert. Flor. 1878, 199, Pl. XXXIII.

This species is referred to by Sir William Dawson with some hesitation as found in the Lignite Tertiary of Western Canada, but he makes no special statement with respect to its general occurrence. It has not appeared since that time, and it is doubtful if it is a real constituent of the flora.

It was first recognized by Lesquereux in 1872 as a constituent of the flora of the Tertiary beds of the Denver group at Golden, Colorado.

Ficus tiliæfolia, Brongn.

Bib: Trans. R. S. C., I, 1882--83, iv, 105: Flor. Tert. Helv., II. 68: Lesq. Tert. Flor. 1878, 203.

Sir William Dawson, in referring to this species as occurring in the Lignite Tertiary of Canada, seems to be somewhat doubtful as to its identity, and as it has not appeared in subsequent collections, it is probably not a constituent of the Canadian Tertiary flora as now known. It has, nevertheless, been recognized by Lesquereux and others in the Fort Union group of Montana, the Denver group of Golden, Colorado, various localities of the Laramie and in the Miocene of California.

Ficus ungeri, Lesq.

Bib: Cret. and Tert. Fl., VIII, 163, pl. XLIV, f. 1-3: Tert. Fl., VII, 195, pl. XXX, f.3.

Two imperfect specimens of *Ficus ungeri*, Lesq., appear in the 1906 collections from Quilchena, which established the first Canadian station. In the United States it has been recorded by Lesquereux from the Green River group of Florissant, Colorado, and Randolph county, Wyoming, but it does not appear to have been observed elsewhere.

Gingko sp.

Bib: Geol. Surv. Can., 1888: Trans. R.S.C., III, 1885, iv, 15--16; VII, 1889.

Specimens of pyritized wood found by McConnell on the Great Bear river, Mackenzie basin in 1888, were referred by Sir William Dawson to the genus *Gingko*, and were regarded

by him as probably the same as previously determined by Schröter. Other specimens of wood supposed to be of this genus had been previously obtained from the Tertiary at Calgary, Alberta.

Gingko adiantoides (Ung.) Heer.

Bib: Trans. R.S.C., IV, 1886, iv, 19--31; VII, 1890, iv, 78, f. 4: U. S. Geol. Surv., Bull. 37, 1887, 15: Fl. Foss, Arct., V, 21, pl. I, f. 7-10.

In 1886, Sir William Dawson described certain fragments of leaves of a species of *Gingko* which he regarded as *G. adiantoides* (Ung.) Heer, from the Lignite Tertiary of Porcupine creek and Great valley; and in 1890 he figured other fragments which he referred to the same species. These were derived from the Tulameen river.

In Lambe's collection of 1906 there was one small fragment of a leaf from the Tulameen and another fragment from Quilchena showing more than half of the leaf. These fragments were undoubtedly the same species and were also identical with Sir William Dawson's specimens. Others were obtained from the Horsefly river as well as from the Tranquille.

FIG. 12. *Gingko adiantoides* (Ung.), Heer.
Fruit with stalk of corresponding fruit
Horsefly River. x 1/1.

In the material from the Horsefly river there was a specimen of a fruit undoubtedly that of a *Gingko* (figure 12), and from the close association of this specimen with the leaves of *Gingko adiantoides,* I have no hesitation in regarding them as of the same species. The fruit answers to the following description:—

Fruit ovoid, acute, 4 mm. wide, 7 mm. long, on a very short stalk and paired with the short stalk of a similar fruit at the summit of a short branch.

In the material from the same and other localities there were several isolated, seed-like bodies of about the same form and size as the above, which may no doubt be regarded as fruits of the same species.

Gingko adiantoides has been recorded from the Livingstone beds of the Bozeman coal-field, Montana, and from the Fort Union group of Seven-mile creek, Montana. Heer has noted its occurrence in the Miocene of Saghalien.

Gingko digitata, (Brongn.) Heer.

In the collection of Ells and Johnston from the Diamond Vale Coal Company at Quilchena, in 1904, there were one or two specimens of a *Gingko* leaf which cannot be separated from Heer's specimen. The formation at that place is regarded as Miocene.

Glyptostrobus europæus (Brongn.) Heer.

Bib: Geol. Surv. Can., 1877-78: Trans. R. S. C., IV, 1886, iv, 23; VIII, 1890, iv, 75-91; I, 1895, iv, 137-161; VIII, 1902, iv, 46: Lat. Ex. Fl. XXXV, 25: Cret. and Tert. Fl. VII, 74.

This widely spread and well known Tertiary species was first recorded by Sir William Dawson in 1887, from Nine-mile creek, Similkameen river. It was later recorded by the same authority from the Lignite Tertiary of Porcupine creek and Great valley; from Burrard inlet, Vancouver, and from Stump lake on the Tulameen river. In 1902 it was determined by Penhallow to occur in the Tertiary of the Red Deer river, while collections of Lambe in 1906 show that it is represented by leafy branches and fruit in the Tertiary beds of the Tulameen, Horsefly and Tranquille rivers, as well as at Quilchena.

Newberry has recorded its occurrence in the Fort Union group of Fort Union, Dakota and Birch bay, Washington; while Lesquereux has also noted its presence in the Miocene of the Bad Lands and at Costello's ranch near Florissant, Colorado. It appears to be a general constituent of the Tertiary flora as far north as Alaska.

GRASS SEEDS.

In the collections from Quilchena, made by Ells and Johnston in 1904, there were a number of very small seed-like bodies which are probably to be regarded as the seeds of grasses.

Grewia sp.

Bib: Geol. Surv. Can, VII, 1894, 36, 37 C.

From the Finlay river Mr. McConnell obtained a leaf which Sir William Dawson regarded as probably a species of *Grewia.*

Grewia crenata, (Ung.) Heer.

Bib: Lat. Ex. Fl., 120, pl. XLVI, f. 2; XLVIII, f. 2, 3: Fl. Tert. Helv., III, 42, pl. CIX, f. 12-21; CX, f. 1-11; 1, 8.

The collections from the Horsefly river in 1906 contained a single specimen of *Grewia crenata* which has been recorded by Newberry from the Miocene of Bridge Creek, Oregon, and by Heer from Europe.

Hypnum columbianum, Penh.

Bib: Trans. R.S.C., VIII, 1890, iv, 75-91: Cont. N.Y. Bot. Gard., No. 93, 1907, 141.

A single specimen of this plant from the Similkameen river in 1890 is thought by Britton and Hollick not to be a *Hypnum,* but rather *Widdringtonia helvetica, Glyptostrobus ungeri* or *Rhynchostegium knowltoni.* It has not since been observed.

Hedera macclurii, Heer.

Bib : Flor. Foss. Arct., I, 119, 138 : Trans. R.S.C., I, 1882-83, iv, 33.

Heer originally observed this plant as a constituent of the Tertiary flora of Northern Greenland, and subsequently found it also in the Lignite Tertiary of Mackenzie river. It has not been found elsewhere, and Dawson's reference to it is only a restatement of Heer's distribution.

Juglans sp.

Bib : Geol. Surv. Can , 1875-76 ; 1887 ; 1877-78.

Various leaves and nuts supposed to represent this genus have been found from time to time on the Quesnel river, the Red Deer river and at Nine-mile creek on the Similkameen river. The leaves from the last location are regarded by Sir William Dawson as allied to *Juglans rugosa*, Lesq.

Juglans acuminata, A. Br.

Bib: Trans. R.S.C., VIII, 1902, 46 : Cat. Cret. and Tert. Fl., 1896, 122.

This species is recorded from the Red Deer river, and also from Port Graham, Alaska.

Juglans cinerea, L.

Bib : Trans. R.S.C., I, 1882-83, iv, 32 : Brit. N. A. Bound. Comm., 1875, App. A. 330.

The only references to the occurrence of this walnut in the Lignite Tertiary of Canada are contained in Sir William Dawson's account of the Lignite Tertiary of Porcupine creek. He seems doubtful as to the specific identity, and considers that there is a resemblance to *J. bilinica*, Ung.

Juglans crossii, Knowlton.

Bib : Trans. R.S.C., I, 1895, iv, 137-161 : Tert. Fl., 289.

The only Canadian record of this species is for Burrard inlet, British Columbia, but it has been recorded in the United States for the Denver group of Carbon, Wyoming; the Livingstone beds of Bozeman coal-field, Montana, and the Green River group of Green river, Wyoming.

This species has been described by previous investigators under the name *Juglans denticulata*, Heer, but Knowlton has shown that this name was previously occupied by O. Weber, and he has therefore transferred the species to *J. crossii.*

Juglans leconteana, Lesq.

Bib : Tert. Fl., 285.

Specimens in the 1898 collection from the Red Deer river constitute the only record of this species in Canadian Tertiary deposits, but Lesquereux records it in the Laramie group of Marshall, Colorado ; at Evanston, Wyoming, and Cherry creek, Oregon.

Juglans laurifolia, Knowlton.

The 1898 collection from the Red Deer river contains a single specimen referable to this species.

Juglans nigella, Heer.

Bib : Geol. Surv. Can., 1875-76 : Tert. Fl., 235 : Fl. Foss. Alask., 38.

The earliest Canadian knowledge of *Juglans nigella* was derived from collections from Quilchena in 1875, and at that time Sir William Dawson regarded the leaves as allied to *J. bilinica.*

This species has been recognized by Lesquereux in the Fort Union group of Montana and the Bad Lands of Dakota ; also by Heer in the Tertiary of Port Graham, Alaska.

Juglans occidentalis, Newb.

Bib: Trans. R. S. C., VIII, 1902, iv. 46 : Lat. Ex. Fl., XXXV, 34, pl, LXV, f. 1 ; LXVI, f. 1-4 : Proc. U. S. Nat. Mus., V, 507.

Three specimens of *Juglans occidentalis* were obtained from the Horsefly river in 1906 and similar specimens had also been secured from the Red Deer river in 1898. Newberry also records it from the Eocene of Green river, Wyoming.

Juglans rhamnoides, Lesq.

Bib : Trans. R. S. C., IV, 1886, iv, 34 : Tert. Fl., VII, 264 ; Cret. and Tert. Fl., VIII, 235.

The only recent record of this plant is from the Tranquille river in 1906, but Sir William Dawson noted it as occurring in the Lignite Tertiary of Porcupine creek and Great valley in 1886. It is also found at Point of Rocks, Wyoming ; Spring canyon, Montana and Black buttes, Wyoming, formations which have been regarded by Lesquereux as Upper Laramie or Lignite Tertiary. It is also a constituent of the Miocene flora of the Bad Lands.

Juglans rugosa, Lesq.

Bib : Trans. R. S. C., IV, 1886, iv, 19-34 : Tert. Fl., 286.

Juglans rugosa has been obtained from the Lignite Tertiary of Porcupine creek and Great valley, in Canada. It also occurs somewhat widely distributed throughout the western United States at Cherry creek, Oregon ; Lassen county, California ; Wickliffe, Kentucky ; Evanston and Black buttes, Wyoming, and in the Denver group of the Bozeman coal-fields, Montana, and Golden, Colorado.

Juglans schimperi, Lesq.

Bib : Trans. R. S. C., IV., 1886, iv, 19-34 : Tert., Fl., 287.

The occurrence of this species in the Lignite Tertiary of Porcupine creek is the only Canadian record, but it is found in the Green River group at Green river, Wyoming, and in the Denver group of Golden, Colorado.

Larix johnseni, Schröter.

Bib : Flor. Foss. Arct., VI., 1880, 15.

The only reference to this wood is contained in the account by Schröter of the woods collected by Sir John Richardson from Great Bear river, Mackenzie basin and among the

specimens submitted to Prof. Heer for determination. No further recognition of this species has been made.

Lastrea fischeri, Heer.

Bib: Trans. R. S. C., VIII, 1902, iv, 46; I, 1895: Lesq., Cret. and Tert. Fl., 239: Heer, Fl. Tert. Helv, I., 34.

A species of somewhat frequent occurrence, the Canadian record including only two localities—Burrard inlet in 1895, and the Red Deer river in 1902. The only United States record is for the Miocene of the John Day valley, Oregon.

Leguminosites ? arachioides, Lesq.

Bib: Geol. Surv. Can., 1877-78; VII, 1894, 23, 37 C: Tert. Fl. VII, 301, pl. LIX, 14: U.S. Geol. Surv. Terr., 1872, 403.

The curious fruit-like bodies originally described by Lesquereux as *Carpolithes arachioides*, and later transferred to the genus *Leguminosites* in consequence of their possible connexion with the leaves of that genus, have appeared in various Tertiary collections from time to time since then. The first appearance of this species in the Canadian Tertiary was in collections from the Similkameen river in 1887, at Nine-mile creek, and in 1894 Sir William Dawson again noted its occurrence in Tertiary beds of the Finlay and Omineca rivers.

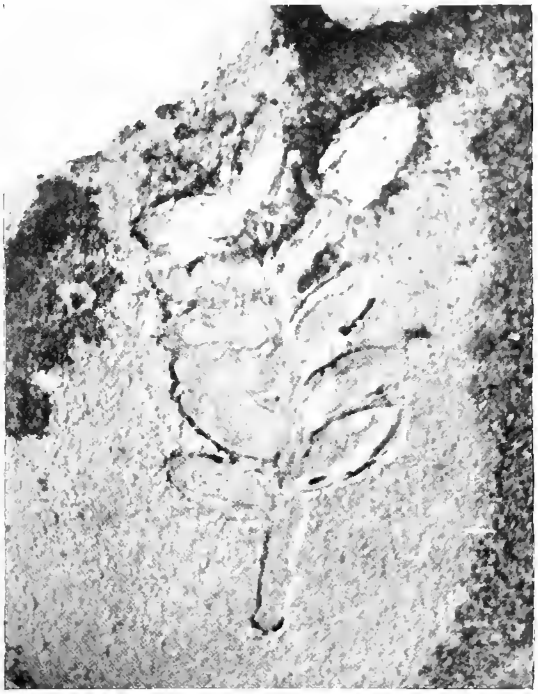

FIG. 14. *Leguminosites ? arachioides*, Lesq.
Fruits from the Horsefly River. x 1/1.

In Lambe's collections from the Horsefly river in 1906 there was a very fine example which is to be distinguished from Lesquereux's type only in the somewhat closer

setting of the fruits on the main axis. (Fig. 14.) As yet, there are no leaves in any of the later collections that can be connected with these fruits.

Lesquereux's specimens were obtained from Evanston, Wyoming, from Clear creek, Montana, and from the Denver group of Middle park, Colorado. The present evidence, therefore, leads to the belief that the species was common to the entire Tertiary area of the United States and Canada.

Leguminosites borealis, Dn.

Bib : Geol. Surv. Can., N. S , IV, 1888--89 : Trans. R.S.C., VII, 1889, iv, 72.

In 1889 Sir William Dawson described a species of *Leguminosites* under the name of *L. borealis.* It was found in a collection of the same year, from the Mackenzie River basin, and its close resemblance to *L. arachioides* was noted. The very slight differences that seem to distinguish it from Lesquereux's species are probably due to conditions of preservation, and the two are no doubt identical.

Lemna scutata, Dn.

Bib : Trans. R.S.C., IV, 1886, iv, 23 ; I, 1895 : Cat. Cret. and Tert. Pl., 1898, 132 : Rep. Geol. 49th Par., 1875, App. A., 329.

This somewhat sparingly distributed species was first found in the Lignite Tertiary of Porcupine creek and Great valley, and has since been found at Burrard inlet, British Columbia. Within United States limits it is also known in the Fort Union group of Burns ranch, Montana, and in the Montana group at Point of Rocks, Wyoming.

Lygodium kaulfusii, Heer.

Bib : Trans. R.S.C., I, 1895 : U.S. Geol. Surv. Terr., 1870, 384 : Fl., 1878, 61 : Cat. Cret and Tert. Pl. 1898, 137.

The only Canadian locality for this species is at Burrard inlet, British Columbia, as recorded by Sir William Dawson in 1895, but it has been observed by Lesquereux in the Green River group of Barrell springs, Wyoming; the Eocene of Cherry and Crescent creeks, Oregon ; of Elk creek, Yellowstone National Park and the Wilkinson coal field, Washington.

Magnolia ? sp.

Bib : Trans. R.S.C., VIII, 1890, iv, 89.

In Lambe's collection from the Tulameen river in 1906 there were a few very imperfect fragments of leaves that appeared to belong to the genus *Magnolia*, but the specific character could not be defined. They may be the same as similar fragments obtained from the Similkameen river in 1890, and referred to the genus without further determination by Sir William Dawson.

Magnolia nordenskioldii, Heer.

Bib : Trans. R.S.C., I, 1882--83, iv, 33 ; VII, 1889, iv, 69 : Flor. Foss. Arct., VI, iii, 16 : Proc. U. S. Nat. Mus., V., 1882, 448.

The first account of this species is contained in Heer's *Flora of Northern Canada* to which Sir William Dawson's subsequent citation refers. Lesquereux, somewhat later, observed it at Chignik bay, Alaska.

Maianthemum grandifolium, Penh.

Bib: Trans. R.S.C., VIII, 1902, iv, 46.

There is only one record of this plant as found in collections from the Red Deer river in 1889. As indicated in the original account there are four European Tertiary representatives of this genus, and only one American representative from the Cretaceous of Staten island. As given by Schimper, and as defined by the figure of *M. pusilum* given by Hollick, there seems to be no essential point of agreement with the Red Deer River material, which represents a different specific type and requires to be separately designated.

Manicaria sp.

Bib: Trans. R.S.C., I, 1895, iv, 143.

The only reference to this species is contained in Sir William Dawson's account of plants from Burrard inlet in 1895.

Musophyllum complicatum, Lesq.

Bib: Tert. Fl., VII, 96, pl. XV, f. 1–6: U.S. Geol. Surv. Terr., 1873, 418.

The very poorly defined, leaf-like remains which Lesquereux described under the above name were first obtained from the Washakie group at Green River station, Wyoming, and from the Laramie group of Golden, Colorado. Since that time there appears to be no record of its occurrence in either the United States or Canada, until the collections of Lambe from the Tulameen river in 1906 brought to view several specimens presenting all the characteristic details of structure and fragmentary condition shown in Lesquereux's figures. The genus and species are without special significance, either from a biological or a stratigraphical point of view.

Myrica ? sp.

Bib: Cret. and Tert. Fl., VIII, 145, pl. XXV, f. 3.

In the collections from the Horsefly river in 1906 there was a specimen of a leaf which, although obscure, appeared to be a *Myrica*, and apparently near to *M. rigida*, Lesq., a species derived from the Green River group of Florissant, Colorado.

Myrica sp.

Bib: Geol. Surv. Can., 1877-78.

An undescribed species, recorded by Sir William Dawson, from Nine-mile creek, Similkameen river, in 1877.

Myrica personata, Knowlton.

Bib: U. S. Geol. Surv., Bull. 204, 1902, 33, pl. III, f. 2.

A fragment of a leaf from the Horsefly river, collected in 1906, appears to be identical with Knowlton's *Myrica personata*, derived from the Miocene of Van Horne's ranch, Oregon. The two localities thus given appear to be the only ones so far known for this plant.

Nelumbium sp.

Bib : Geol. Surv. Can., 1877-78.

A fragmentary leaf from the Similkameen river at Nine-mile creek is referred by Sir William Dawson to the genus *Nelumbium.* It may be identical with the next.

Nelumbium pygmæum, Dn.

Bib: Trans. R.S.C., VIII, 1890, iv, 87; VIII, 1902, iv, 68.

The original specimens of this plant were first found one mile above Princeton in the Tulameen river, as recorded by Sir William Dawson. In 1902 additional specimens were recorded by Penhallow from the Horsefly river, while yet other specimens were brought to light in the 1906 collections from the Similkameen river.

Nelumbium saskatchuense, Dn.

Bib: Geol. Surv. Can., 1887 : Trans. R.S.C., V, 1887, iv, 35.

There is only one record of this species from the Red Deer river, in 1887.

Neuropteris civica, Dn.

Bib: Trans. R.S.C., I, 1895, iv, 141.

The only record of this fern is contained in Sir William Dawson's account of Eocene plants from Burrard inlet, British Columbia.

Nordenskioldia borealis, Heer.

Bib: Geol. Surv. Can., 1888-89; Trans. R. S. C, VII, 1889, iv, 71 : Geol. Surv. Can., 1875-76 : Lesq., Fl. Dak. Gr. 1892, 219; Fl. Foss. Arct. II, 65.

The first Canadian records for this plant in 1875 show its occurrence in the Tertiary beds of the Quesnel river. In 1889 Sir William Dawson again recorded its occurrence in the Miocene of Great Bear river. Of its further distribution in Canada nothing is at present known.

In the United States, Lesquereux has noted its occurrence in the Dakota group of Kansas.

Nyssidium ? sp.

Bib: Geol. Surv. Can., 1875-76.

The single specimen referred with hesitation to this genus, by Sir William Dawson in 1875, was obtained from the Quesnel river, but it possesses little or no value for stratigraphical purposes.

Onoclea sensibilis, Newb.

Bib: Geol. Surv. Can., 1887 : Trans. R. S. C., IV, 1886, iv, 19-34 : Lat. Ex. Fl., 1868, 39; Cret. and Tert. Fl., 1878, pl. VIII, IX.

The first Canadian record for this fern is from the Lignite Tertiary of Porcupine creek in 1886. In 1887 Sir William Dawson also observed it in the collections from Red Deer river; and in 1906 three fragments were obtained from the Horsefly river.

Lesquereux had already noted its occurrence in the Fort Union group of Fort Union, North Dakota.

Osmunda heerii, Gaudin.

Bib: Fl. Tert. Helv., III, 55, pl. CXLIII, f. 1: Fl. Foss. Arct., I, 88, pl. I, f. 6-11, pl. VIII, f. 15 B.

In his Tertiary flora of Helvetia Heer figures several specimens of this fern to which Gaudin had already applied the name *Osmunda heerii*. This plant is commented upon as being very near to *O. regalis* of the present day. The same species has appeared in the Miocene of northern Greenland and Siberia, and in both of these latter cases Heer comments upon their very remarkable resemblance to *O. regalis*.

In the 1906 collections from the Tulameen river there was a fern which cannot well be separated from this species. It shows, however, much larger pinnules, but this may well be due to conditions of growth, since precisely parallel differences may be found in growing specimens of *O. regalis*. One of the characteristic features of *O. heerii* is to be found in the serrated margins of the pinnules, and in this respect it seems to be approached by the Tulameen specimen much more nearly than the *O. regalis*, as represented by the specimens found in herbaria. But a careful and extended examination of growing specimens of the royal fern has convinced me that such serration is a character of great inconstancy, that it is, in many cases, as well defined as in *O. heerii*, and that if the plant were to be subjected to the conditions usually attending fossilization its separated parts would present just the differences which may be observed in comparing it with the Tulameen specimen. There therefore seems good reason for believing that *O. heerii* is nothing less than the ancestral form of the existing royal fern.

Osmunda macrophylla n. sp.

This hitherto unpublished species was found in 1887, in the collections of Lambe from the Red Deer river, at the mouth of the Blindman. It could not be correlated with any of the previously observed Osmundas, although it may be identical with some one, particularly *O. heerii*. But the shape of the pinnules, and especially the breadth of their bases, seems to prohibit any such association. In the circumstances it has seemed better to assign it a separate name, the justification for which appears in the apparently larger size of the fronds, as indicated by the width of the pinnules. Fig. 15.

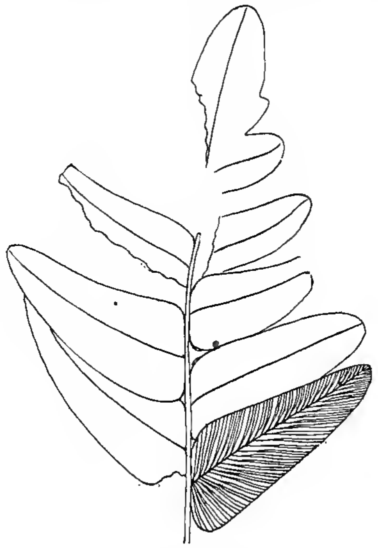

FIG. 15. *Osmunda macrophyla* n. sp.
Extremity of a frond from the Red Deer River. x 1/1.

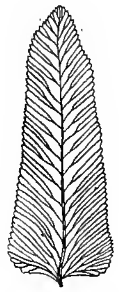

FIG. 16. *Osmunda regalis*, L.
A single pinna showing the form and margin. x 1/1.

Paliurus? sp.

Bib: Geol. Surv. Can., 1877-78, 186 B.

The only reference to this doubtful specimen is to be found in Sir William Dawson's account of plants from Vermilion cliff on the Tulameen river, published in 1877.

Paliurus colombi, Heer.

Bib: Trans. R.S.C., IV, 1886: Fl. Foss. Arct., I, 122: U.S. Geol. Surv. Terr., 1871, 288: Tert. Fl., 1878, 273.

Paliurus colombi is found in the Fort Union group of the Yellowstone river, Montana; the Denver group of Creston, Wyoming; the Miocene of John Day valley, Oregon, and the Lignite Tertiary of Porcupine creek, Saskatchewan, which is the only Canadian locality so far known.

Phragmites sp.

Bib: Trans. R.S.C., IV, 1886.

The very unsatisfactory fragments of leaves usually known as *Phragmites* have been found in the Lignite Tertiary of Porcupine creek, at Coal gully, at Kettle river, and in the Miocene of the Similkameen river.

Phyllites sp.

Bib: Trans. R.S.C., IV, 1886.

An undescribed species of Phyllites was recorded by Sir William Dawson from the Lignite Tertiary of Porcupine creek and Great valley in 1886.

Phyllites aceroides, Heer.

Bib: Trans. R.S.C., I, 1882-83, iv, 33; VII, 1889, iv, 69: Flor. Foss. Arct., I, 139.

Dawson's reference to this species is a citation of Heer's account which is the only real record of this leaf in the Lignite Tertiary of Canada, but as the account is founded upon a small fragment of the tip it is not very reliable.

Phyllites carneosus, Newb.

Bib: Trans. R.S.C., VIII, 1902, iv, 46: Lat. Ex. Fl., 1868, 75.

There appear to be only two records for this leaf—one from the Fort Union group of Fort Union, North Dakota, the other from the Red Deer river in Canada.

Phyllites cupanioides, Newb.

Bib: Trans. R.S.C., IV, 1886, iv, 32: Lat. Ex. Flor., XXXV, 1898, 135.

This species was observed by Dawson in the Lignite Tertiary of Great valley, and was incorrectly published by him as *P. caparinoides*, Newb. It is a species which Newberry originally obtained from the Fort Union group of Dakota.

Phyllites venosus, Newb.

Bib : Trans. R.S.C., IV, 1886 : Lat. Ex. Fl., 1868, 75.

This species is confined to precisely the same localities as the last.

Picea tranquillensis n. sp.

In the 1906 collections from the Tranquille river there was a single leaf of a Picea (fig. 17) which answers to the following description :—

Leaf very slightly curved; slightly contracted at the base; apex obtuse; 1.5 mm. broad, 15 mm. long; one nerved or slightly channelled on the upper side.

FIG. 17. *Picea tranquillensis* n. sp.
A single leaf from the Tranquille River. x 1/1.

Picea columbiensis Penh.

Bib : Trans. R.S.C., XIII, 1907, iv.

This species, represented by leaves and cones, was obtained from the Kettle river in 1905. No further specimens have been found.

Picea quilchenensis n. sp.

A single leaf obtained from the Miocene of Quilchena in 1904, by Ells and Johnston, may be only a form of *P. tranquillensis*, but its somewhat greater length would seem to suggest another species. It answers to the following description :—

A single leaf 27 mm. long, 1.5 mm. wide at its greatest breadth; narrowing gradually to the base; apex acute; channelled, curved. Fig. 18.

FIG. 18. *Picea quilchenensis* n. sp.
A single leaf from Quilchena. x 1/1.

Pinus sp.

Bib : Geol. Surv. Can., 1875-76, 259-260.

In 1875 Sir William Dawson observed in the collections from the Blackwater river two seed-like bodies which he regarded as probably representing two species of pine. In the 1906 collections of Lambe similar bodies, together with scales and possibly larger

fragments of cones, were brought together from a number of localities. From the Tulameen there was a scale; from the Tranquille river there was an impression which was interpreted as representing the end view of a cone, but the material had been so crushed out of shape as to lead to nothing very definite; from Quilchena there were obtained seed-like bodies which appeared to be those of a pine devoid of the wings; and a number of similar seed were obtained from the Horsefly river. As well defined remains of pines, of recognizable species, occur in the same deposits, these bodies undoubtedly belong to them, but the precise specific correlation cannot be ascertained.

Pinus columbiana, Penh.

Bib: North American Gymnosperms, 1907.

Wood and cones of *Pinus columbiana* were obtained from the Kettle river in 1905, by Dr. R. A. Daly. There is no other record of the species.

Pinus lardyana, Heer.

Bib: Fl. Tert. Helv. III, 161, pl. CXLVI, f. 2.

Two fragments of cones from Quilchena, in the collections of 1906, represent a species of pine which cannot be fully identified because the elements of size and shape are wanting, but a careful comparison of Heer's *Pinus lardyana* shows what may be regarded as an exact correspondence with respect to the size, shape and configuration of the scales. This correspondence is to be observed with respect to the figures given in volume III, plate CXLVI, figure 2 of the Tertiary flora of Helvetia, but it does not apply to figure 3, nor to the cone depicted in volume I, plate XX, figure 5, both of which appear to me to be wholly distinct.

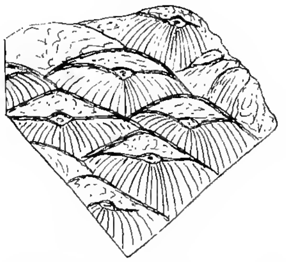

FIG. 19. *Pinus lardyana*. Heer.
A fragment of cone from Quilchena. x 1/1.

Pinus steenstrupiana, Heer.

Bib: Fl. Foss. Arct. I, pl. XXIV, 23-26, 135.

In the Quilchena collection of 1906 there were several more or less perfect coniferous scales (figs. 20–21) which were found to be identical with Heer's *P. steenstrupiana* from the

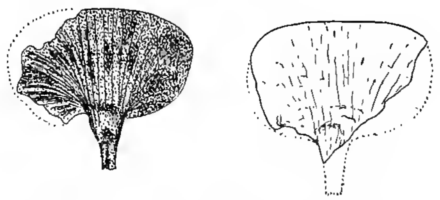

FIG. 20 & FIG. 21. *Pinus steenstrupiana*, Heer.
Two scales of a cone from Quilchena. x 1/1.

Miocene of Hredavatu in the Archipelago of arctic America, and the Mackenzie River basin. In the same collection there were also two seeds so related to one another (figure 22) and

FIG. 22. *Pinus steenstrupiana*, Heer.
Two young seeds from Quilchena. x 1/1.

so associated with the scales as to suggest that they were of the same species and in that position which they had at the time the scale was removed by decay. The absence of wings indicates that the seeds had also been subject to decay, but of such a limited nature as to leave them nearly intact. In a few instances there were perfect seeds (figure 23), these may belong here, but they may also be the seeds of *P. lardyana.*

FIG. 23. *Pinus steenstrupiana*, Heer.
Two fully developed seeds from Quilchena. x 1/1.

Pinus trunculus, Dn.

Bib: Trans. R. S. C., VIII, 1890, iv, 78; Miocen. Fl. Spitz., V: Trans. R. S. C., VIII, 1902, iv. 68.

In 1890 Sir William Dawson described under the name *Pinus trunculus* a group of pine leaves from the Similkameen river, which was not complete. He also refers to the fact that the same type of leaves is to be found at Stump lake and on the Tranquille river.

In the collections of Mr. Lambe in 1906 there were a large number of pine leaves, especially from the Tranquille river, and many of these could be correlated with *Pinus trunculus* without any difficulty. From this material it becomes possible to gain a more correct conception of the proper dimensions of these organs than could be got from the original, truncated specimens of Sir William Dawson. The specimens from the Tranquille river were especially

good (figure 25), and show that the leaves were five in number, from a prominent but short base, and that they were rather stout and at least 17 cm long.

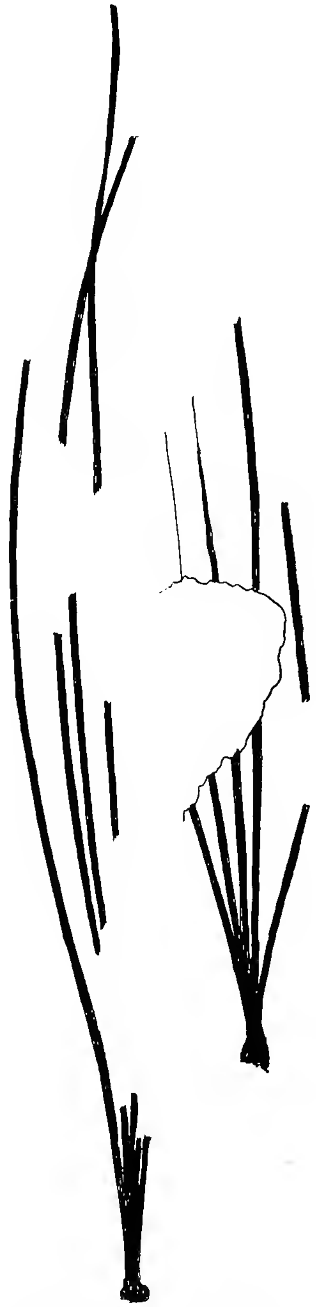

FIG 25. *Pinus trunculus*, Dn.
Leaves from the Tranquille River. x 1/1.

At Quilchena the same leaves are found in a much more fragmented condition, but they present precisely the aspect of the leaves figured by Heer from the Miocene of Spitzbergen. These specimens were collected by Ells and Johnston in 1904, but in the collections of

Lambe in 1906 there were specimens of pine leaves of the same type, together with other shorter and more delicate leaves, possibly of the same species but younger or representing arrested development (figure 24) Leaves of identical character have also been found in the

FIG. 24. *Pinus trunculus*, Dn.
Young leaves from Quilchena and Tulameen River. x 1/1.

collections from the Tulameen and Horsefly rivers, and from the Tranquille river there were found leaf scars on a short section of stem, which are no doubt of the same character.

FIG. 26. *Pinus trunculus*, Dn.
Seed from the Tranquille River. x 1/1.

A number of seeds of a pine were found in the collections from the Tulameen and Tranquille rivers (figures 26 and 27), and the facts of association seem to render it probable that they also represent this species, although they may belong to one of the others described.

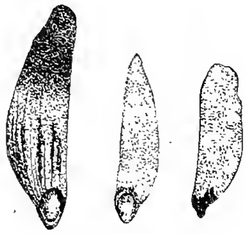

FIG. 27. *Pinus trunculus*, Dn.
Seeds from the Tulameen River. x 1/1.

A small fragment of a cone was found in the collection from the Tranquille river (figure 28). As shown, the specimen is very incomplete, showing neither base, apex nor complete

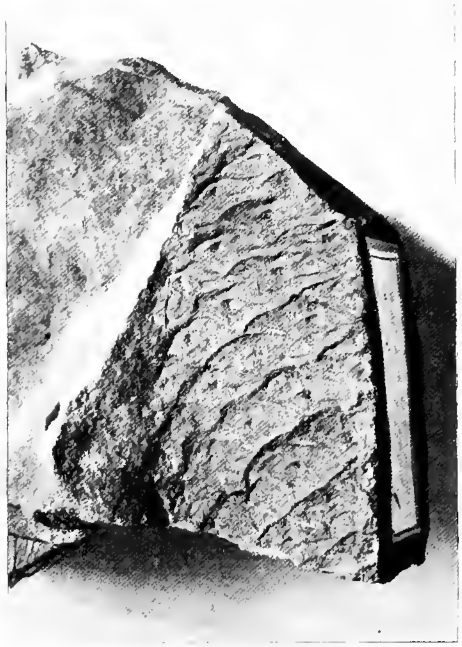

FIG. 28. *Pinus trunculus*, Dn.
Fragment of cone from Tranquille River. x 1/1.

form, but from the curvature of the side, which has been preserved with fair completeness, as well as from the size of the scales, it is evident that the cone is that of a hard pine and evidently one of fairly large size. Its very close association with the leaves of *P. trunculus* leads to the conclusion that it may be of the same species, and it is provisionally so designated.

From the material so far obtainable it is not easy to correlate *P. trunculus* with any existing species, but the following observations may be made.

In discussing the possible affinities of this species Sir William Dawson directed attention to the apparent relation of the leaves to *P. rigida* and *P. taeda*. In a somewhat more critical comparison of both leaves and cone with the various types of hard pine I find there is no direct relation with *P. rigida*, and *P. taeda* fails to satisfy necessary conditions inasmuch as it has only three leaves in a fascicle, while *P. trunculus* has five, but otherwise there is a close correspondence in length. *P. torreyana* bears five leaves which are somewhat longer than in *P. trunculus*, but the character of the cone is not the same. *Pinus serotina* agrees well with respect to the length of leaves and the character of the cone, but the number of leaves —three—is too small. In *Pinus arizonica*, the five leaves are 17 cm. long, and the cone presents a very close resemblance, and from a consideration of all these facts I am inclined to believe that it gives a closer approximation to the affinities of *P. trunculus* than any other existing species. It will, nevertheless, require the confirmation of more ample material to render this tentative conclusion a valid one.

Pinus tulameenensis n. sp.

In the material from the Tulameen river there was one specimen of pine foliage showing four small leaves in a fascicle, (Figure 4). These may be described as follows:—

FIG. 34. *Pinus tulameenensis* n. sp.
Leaves from Tulameen River. x 1/1.

Leaves four, very slender, 23 mm. long, 0.30 broad with one nerve?; apex acute.

It is possible that figure 23, referred to *P. steenstrupiana*, may belong here.

Planera crenata, Newb.

Bib: Proc. U. S. Nat. Mus., V, 1882, 508: Lat. Ex. Fl., XXXV, 81, pl. LVII, f. 3: Trans. R.S.C., I, 1895.

This leaf was first recorded by Sir William Dawson in 1895 from Burrard inlet, British Columbia; and in 1906 it was obtained from the Horsefly river where it was represented by a small fragment only. The only record for the United States is that given by Newberry, who noted its occurrence at Tongue river, Montana

Planera longifolia, Lesq.

Bib: Tert. Fl. VII, 189: U.S. Geol. Surv. Terr., 1872, 371: Cret. and Tert. Fl., VIII, 161, pl. XXIX, f. 1-3: XLIV, f. 10; Trans. R.S.C., VIII, 1890, iv, 85; VIII, 1902, iv, 68.

Planera longifolia is a very well characterized species which was first obtained from the north fork of the Similkameen river in 1896, as recorded by Sir William Dawson; and in 1891 it was obtained from the Horsefly river.

In 1906 it was found in collections from the Tranquille river, in which it was represented by one fragment only, but numerous fairly good specimens were obtained from the Tulameen river—essentially the same locality as that from which Sir William Dawson's specimens were derived—and it was yet more abundant in material from the Horsefly river, the specimens being characterized by their well defined venation and well defined though never complete margins.

Both Newberry and Lesquereux have shown that this species is a constituent of the flora of the Green River group of Elko station, Nevada, and Florissant, Colorado.

Platanus sp.

Bib: Geol. Surv. Can., 1871-72, 59; 1877-78, 187 B.: Trans. R.S.C., I, 1895.

In 1871 Sir William Dawson referred to imperfect specimens of leaves from the mouth of the Quesnel river, as of a species of Platanus, and also directed attention to the occurrence in

the same beds of a wood which he referred to the same genus, but without specific determination. In 1888 he recorded what seemed to be the same species, at Nine-mile creek, Similkameen river, and in 1885, similarly imperfect leaves, possibly of the same species, were obtained from Burrard inlet, British Columbia.

Platanus aceroides, Goepp.

Bib: Geol. Surv. Can., 1875-76: Amer. Jn'l Sc., XLV, 1869, 206: Tert. Fl. 1878, 184.

This European, Miocene species is common to a large number of localities in the United States, being found in the Fort Union group in the Bad Lands of Dakota; the Livingston beds of Bozeman, Montana; the Denver group of Golden, Colorado and Carbon, Wyoming; the Laramie group of Black Buttes, Wyoming, and the Miocene of the John Day valley, Oregon.

In Canada, only two stations are at present known, the Mackenzie river and the Quesnel river of British Columbia.

Platanus aceroides ? Goepp.

Bib: Trans. R.S.C., VII, 1888-89, iv, *ante* p. 93.

The determination of this species was made by Sir William Dawson in 1888, and is open to question on account of the imperfect nature of the specimen, which was a piece of wood. It was obtained from the Miocene of Bear river, Mackenzie basin, and was referred provisionally to the above, since it seemed to correspond to the same species of wood as determined by Schroeter.

Platanus haydenii, Newb.

Bib: Geol. Surv. Can., VII, 1894, 36, 37C.: Trans. R.S.C., IV, 1886: Lat. Ex. Fl. 1868, 70; Cret. and Tert., Fl. 1883, pl. XIX, XX, XXI.

This very well characterized species is recorded for the Fort Union group of the Yellowstone river, Montana; the Denver group of Sedalia and Golden, Colorado, and the Laramie group of Sand creek, Colorado.

In Canada it was first recorded for the Lignite Tertiary of Porcupine creek and Great valley in 1886, and in 1894 it was observed in collections from the Omineca river, British Columbia.

Platanus heterophyllus, Newb.

Bib: Trans. R. S. C., I, 1882-83, iv, 32: Brit. N. A. Bound. Com., 1875, App. A. 330.

The above is recorded by Sir William Dawson as occurring at Wood End, as a loose fragment, but probably from the Lignite Tertiary. It also occurs in the Fort Union group of the United States.

Platanus nobilis, Newb.

Bib: Geol. Surv. Can., 1879-80: Trans. R.S.C., III, 1885; IV, 1886: iv, 24: Lat. Ex. Fl. 1868, 67.

Within the United States this species is known in the Fort Union group at Seven-mile creek, Montana, and the Miocene of the John Day valley, Oregon. In Canada it was first recorded from the Souris river, Saskatchewan; at a later date from Calgary, Alberta, and finally from Porcupine creek and Great valley, Saskatchewan. All of these localites are recognized as belonging to the Lignite Tertiary.

Platanus raynoldsii, Newb.

Bib: Trans. R.S.C., III, 1885: IV, 1886: Lat. Ex. Fl., 1868, 69: Tert. Fl., 1878, 185.

The distribution of this species is very similar to the last. In the United States it is found in the Fort Union group of Montana; the Denver group of Golden, Colorado, and the Miocene of the John Day valley, Oregon. The Canadian distribution is less extensive, but it has been obtained from the Lignite Tertiary of Porcupine creek, Saskatchewan, and of Calgary, Alberta.

Podocarpites tyrrellii, Dn.

Bib: Trans. R.S.C., V, 1887, iv. 35.

The only record of this species is contained in an account of the Laramie formation in 1887. This specimen was obtained, from Vermilion river, of the Belly River series, and the comment is made that while the genus is known to the Eocene of Europe, it does not appear on this continent higher than the Cretaceous.

Populus sp.

Bib: Geol. Surv. Can., 1871-72, 59.

A branch of a tree from Quilchena has the general aspect of a poplar, and it may be the same as leaves and wood referred to by Sir William Dawson as derived from the Quesnel river in 1871.

Populus acerifolia, Newb.

Bib: Lat. Ex. Fl., XXXV, 37 pl. XXVIII, f. 5-8: Cret. and Tert. Fl., 1878: Trans R.S.C., IV, 1886, iv, 27; III, 1885: Geol. Surv. Can., 1887, 136E.

Lesquereux has recorded *Populus acerifolia* from the Fort Union group of the Yellowstone river, Montana, and Fort Union, Dakota, which appear to be the only localities in the United States so far noted. In Canada it seems to have been a widely distributed species in Tertiary time, since it has appeared in nearly all collections and from a large number of localities. It was first noted as occurring in the Tertiary of Calgary, Alberta, in 1885. In the following year Sir William Dawson observed it in the Lignite Tertiary of Porcupine creek and Great valley, and in 1887 it was obtained from the Red Deer river. In 1906, Lambe secured it from Quilchena, Coal gully, and both the Tranquille and Horsefly rivers, a distribution which seems to imply that it was a species common to the entire Tertiary area.

Populus arctica, Heer.

Bib: Tert. Fl., VII, 179, pl. XXIII : Cret. and Tert. Fl., VIII, 225, pl. XLVI : Geol. Surv. Can, 1877, 78, 186 B; 1875-76 : 1887, 137 E; N Ser. IV, 1888-89; VII, 1894, 36, 37 C; 231 B: Trans. R.S.C., IV, 1886; VII, 1889.

This very abundant and well characterized species is found in the United States ranging from the Laramie to the Miocene. It is an almost invariable element of all Tertiary collections. In Canada it is similarly abundant, having appeared in all collections from 1863 to the present time. The localities recorded are Coal brook, Quesnel, Nine-mile creek, Similkameen river, Red Deer river, Bear river, Mackenzie basin, Omineca river and the Lignite Tertiary of Porcupine creek and Great valley.

Populus arctica latior, Heer.

Bib: Geol. Surv. Can., N. Ser., IV. 1888–89 : Trans. R.S.C., VII, 1889.

The only reference to this leaf is contained in Sir William Dawson's account of plants from the Bear river, Mackenzie basin, collected in 1888.

Populus balsamoides, Goepp.

Bib: Trans. R.S.C., I, 1895 : Fl. Foss. Alask., 1869, 26 : U.S. Geol. Surv. Terr., 1871, 299.

So far as present records go, *Populus balsamoides* appears to be a somewhat unusual type of poplar of restricted distribution. In the United States it has been met with at Yellowstone lake and at Corral Hollow, California; and in Alaska it is recorded from Port Graham. In Canada it is known only from Burrard inlet, British Columbia, where it was found in 1895.

Populus cordata, Newb.

Bib: Lat. Ex. Fl., 1868, 60 : Cret and Tert. Fl., 1878, pl. XIV : Fl. Foss. Arct., II, 26, pl. II, f. 5.

Although this is a well known arctic species, it has been recorded for only one station in the United States—the Fort Union group of the Yellowstone river, Montana. In Canada it was obtained in the collections of 1906, from Quilchena and the Tulameen river, but it has appeared nowhere else. This may be due to the very striking resemblance it bears to, and the difficulty of properly differentiating it from, *P. zaddachi.* An examination of Heer's figures of this latter species, as given in his Arctic Flora, shows a very wide variation of forms which may belong to the same species, but which suggest that according to the limits usually adopted in making species of fossil plants, there are really more than one: and there is a very strong suggestion that *P. cordata* may be only a variant of *P. zaddachi.*

Populus cordifolia, Newb.

Bib: Trans. R.S.C., III, 1885, iv, 17 : Lat. Ex. Fl., 1868, 18.

The Lignite Tertiary of Calgary, Alberta, is the only record of *P. cordifolia* for Canada, and the Dakota group of Nebraska is the only locality in the United States.

Populus cuneata, Newb.

Bib : Lat. Ex. Fl. XXXV, 41, Pl. XXIX, f. 7 ; XXVIII, f. 2–4 : Cret. and Tert. Fl., 1878.

This somewhat rare species of poplar is known in the United States in only two localities, the Fort Union group of the Yellowstone river, Montana and the Bad Lands of Dakota. The first Canadian record was from the Red Deer river in 1897, and it has since then been obtained by Lambe from both the Tranquille and the Tulameen rivers.

Populus daphnogenoides ? Ward.

Bib : Trans. R.S.C., VIII, 1890 ; VIII, 1902, iv, 46 : U.S. Geol. Surv., Bull. 37, 1887, 20.

The fragments referred to *Populus daphnogenoides* with some hesitation were first obtained from the Similkameen river, by Sir William Dawson in 1890, and in 1902 Penhallow observed fragments of similar leaves in collections from the Red Deer river.

Populus genetrix, Newb.

Bib : Lat. Ex. Fl. XXXV, 44, pl. XXVII, f. 1 : Geol. Surv. Can., VII, 1894, 231 B : Trans. R.S.C., III, 1885 ; IV, 1886, iv, 17.

The only United States locality for *Populus genetrix,* as recorded by Newberry, is the Fort Union group of the Yellowstone river, Montana. In Canada it is a much more abundant species, being found at Coal brook, British Columbia, and in the Lignite Tertiary of Porcupine creek, the Great valley and Souris river, and more recently at Quilchena.

Populus hookeri, Heer.

Bib : Geol. Surv. Can., N. Ser., VI, 1888-89 : Trans. R.S.C., VII, 1889, iv, 71 : Fl. Foss. Arct. I, 1868, 137.

Populus hookeri is an arctic species which, as yet, appears to have given evidence of only a sparing extension south of Greenland. The only record is that of Sir William Dawson in 1889, for the Eocene of Bear river, Mackenzie basin.

Populus latior, A. Br.

Bib : Fl. Tert. Helv. II, 11, pl. LIII, f. 1, 5, 7, 8, 10, LIV, LV. LVI, LVII ; III, 173 : Geol. Surv. Can., 1877-78, 186 B.

The distribution of *Populus latior* appears to be confined to high latitudes, since it is not known in the Tertiary of the United States, and its greatest southern extension is found on the Similkameen river in British Columbia. From this locality it ranges northward to Port Graham in Alaska.

In the Canadian Tertiary it appears to be a somewhat abundant species, and many of the leaves found were preserved in a very perfect condition. It has so far been found at Nine-mile creek on the Similkameen river, at the Horsefly river, and at the Tulameen. The branch already described and found in the collection from the Horsefly may belong to this species.

Populus latior cordifolia, Heer.

Bib : Fl. Tert. Helv. II,, 12, pl. LV, f. 4 : U. S. Geol. Surv. Terr., 1871, 289.

There appears to be only one record for this form of *Populus latior*, from the Laramie group of Medicine bow, Wyoming. Its appearance in the collections of 1906, from the Tulameen river, constitutes our first knowledge of it within Canadian limits.

Populus mutabilis oblonga, Heer.

Bib : Fl. Tert. Helv., II, 21, pl. LX, f. 15, 16.

The collections of 1906, from both the Tranquille river and Quilchena, contained fragmentary specimens of leaves which are to be referred to *Populus mutabilis oblonga*, Heer. This European form has not been recorded from any other localities in either Canada or the United States.

Populus nebrascencis, Newb.

Bib : Lat. Ex. Fl., XXXV, 47, pl. XXVII, fig. 4, 5 : Geol. Surv. Can., VII, 1894, 36, 37 C.

One specimen of this well characterized species was found in the 1906 collection from Quilchena. It had already been observed in 1894, in collections from the Omineca river. Newberry records it from the Fort Union group of the Yellowstone river, Montana, as well as from the Denver group of Golden, Colorado.

Populus nervosa, Newb.

Bib : Trans. R.S.C., V, 1887, iv, 35 : Lat. Ex. Flor., XXXV, 1868, 61.

Newberry originally described this species from the Fort Union group of Montana. Dawson later recorded it from the Lignite Tertiary of the North Saskatchewan at Rocky Mountain house.

Populus obtrita, Dn.

Bib : Trans. R.S.C., VIII, 1890, iv, 82, f. 12 ; VIII, 1902, iv, 16.

So far as present records show *Populus obtrita* is an exclusively Canadian species. It was first described by Sir William Dawson on the basis of specimens obtained from the Similkameen river. It is so well characterized as to be distinguished without difficulty. Since its first recognition it has been obtained from the Red Deer river and from Quilchena, and in the collections of Mr. Lambe in 1906. It was also found in material from Quilchena and the Similkameen river.

Populus polymorpha, Newb.

Bib : Lat. Ex. Fl., XXXV, 50, pl. XLIX, f. 4, 7, 9 : Proc U. S. Nat. Mus., V, 1882, 506.

Populus polymorpha is a somewhat rare species first obtained by Newberry from the Miocene of Bridge creek, Oregon. In 1904 it was obtained by Ells and Johnston from Quilchena, and in 1906 it appeared in Lambe's collections from Coal gully, British Columbia. As indicated by the name, the species presents wide variations of form, and it is altogether probable that it really embraces more than one species.

Populus richardsoni, Heer.

Bib : Geol. Surv. Can., 1887, 136 E : Trans. R.S.C., IV, 1886; VIII, 1902, iv, 46 : Fl. Foss. Arct., I, 1868, 98 : U. S. Geol. Surv. Terr., 1873, 411 : Tert. Fl., 1878, 177.

This apparently northern type is abundant throughout the Tertiary of the United States, where it has been recorded by Lesquereux for the Green River group of Elko station, Nevada, and the Fort Union group of Montana. It is, however, more abundant toward the north, ranging as far as Greenland and Alaska. In Canada it has been found at the Red Deer river, and in the Lignite Tertiary of Porcupine creek ; Calgary, Alberta, and the Mackenzie river.

Populus rotundifolia, Newb.

Bib : Lat. Ex. Fl., XXXV, 51 : Proc. U. S. Nat. Mus., V, 1882, 506 : Trans. R.S.C., I, 1895.

Newberry's record for this species shows that it is at present known in only two localities in the United States—the Fort Union group of the Yellowstone river in Montana, and Carbon station, Wyoming. The first Canadian record by Sir William Dawson in 1895 shows it to be a constituent of the flora of Burrard inlet, British Columbia, while Lambe's collections of 1906 gave it a position in the Miocene of the Similkameen river.

Populus speciosa, Ward.

Bib . U. S. Geol. Surv. Bull. 37, 1887, 20 : Geol. Surv. Can., VII, 1894, 36, 37 C.

A rare species first recorded by Ward from the Fort Union group of Clear creek, Montana, but in 1894 obtained by Sir William Dawson from the Omineca river, British Columbia.

Populus subrotunda, Lesq.

Bib : Geol. Surv. Can., 1877-78, 186 B : Amer. Jn'l. Sc., XLV, 1868, 205.

This species has been recorded by Lesquereux from Carbon, Evanston, Rock creek and Laramie plains, Wyoming; but Coal brook, British Columbia, is the only station so far known in Canada.

Populus ungeri, Lesq.

Bib : Trans. R. S. C., VIII, 1902, iv, 46 : Tert. Fl., 1878, 175.

One of the rarest poplars in North America. In the United States it is known only in the Denver group of Golden, Colorado. In Canada, it was obtained from the Red Deer river in 1898 as recorded by Penhallow.

Populus zaddachi, Heer.

Bib : Cret. and Tert. Fl., VIII, 158, pl. XXXI, f. 8 : Mioc. Fl. Alask., II, pl. II, f. 5 : Mioc. Fl. Sachalin, p. 25, pl. IV, f. 1-3 : Fl. Tert. Helv., III, 307 : U. S. Geol. Surv. Terr., 1871, 292.

Populus zaddachi is one of the best characterized and most widely distributed species of poplar in both Europe and America. In Alaska it is found at Port Graham. In the

United States it occurs in the Miocene of Chalk bluffs, California ; the Green River group of Florissant, Colorado, and the Fort Union group of Montana and Dakota.

Well characterized fragments of this leaf have been met with in the Tertiary beds of the Tranquille and Tulameen rivers of British Columbia.

As elsewhere observed, the limitations of *P. zaddachi* are not well defined, and I have selected as the type, those forms which Heer figures in his flora of Saghalien. The figures given in his flora of Alaska deviate strongly, and should be assigned to *P. cordifolia.*

Potamogeton sp.

Bib : Trans. R.S.C., XIII, 1907, iv.

From time to time, collections of Tertiary plants have embraced specimens of poorly preserved plants apparently referable to the genus *Potamogeton.* In Dr. Daly's collection from the Kettle river in 1905 there were fruits which seem to belong here.

Potamogeton ? verticillatus, Lesq.

Bib : Cret. and Tert. Fl., VIII., 142, pl. XXIII, f. 5, 6 :

In 1883, Lesquereux described a specimen from the Green River group of Florissant, Colorado, which he believed to be a *Potamogeton*, and assigned to it the name of *P. verticillatus.* In Lambe's collections from the Tulameen river in 1906 there was a specimen which seemed to be identical with Lesquereux's specimen. It may be described as follows :

Leaves thin, slender, linear lanceolate, 45 mm long, whorled ; 2 mm broad, diminishing slightly at the base; slightly channelled above.

Prunus merriami, Knowlton.

Bib: U.S. Geol. Surv., Bull. 204, 67, pl. XI, f. 2, 3, 6, 7.

This somewhat recently discovered species from the Miocene of Van Horne's ranch, in the John Day basin, Oregon, is represented by a single specimen in the Tertiary flora of Quilchena, British Columbia.

Pseudotsuga miocena, Penh.

Bib : Trans. R.S.C.,, VIII, 1902, iv, 68; IX, 1903, iv, 33.

This species is represented altogether by the wood, and as yet it has not been found elsewhere than in Canada. It was first observed in the Miocene of the Horsefly river, and in 1903 it was obtained from the Lignite Tertiary of Porcupine creek, Saskatchewan.

Pteris sitchensis, Heer.

Bib: Geol. Surv. Can., N. Ser., IV, 1888–89 : Trans. R.S.C., VII, 1889, iv, : Fl. Foss. Alask., 1869, 21.

This apparently northern type of fern was first obtained by Heer from Sitka, Alaska ; but it has since been recorded by Sir William Dawson from the Lignite Tertiary of the Bear river, Mackenzie basin.

Pterospermites sp.

Bib: Geol. Surv. Can., 1871-72, 59.

In 1871 Sir William Dawson recorded a species of *Pterospermites* from the Quesnel river, but was not able to assign a specific name.

Pterospermites dentatus, Heer.

Bib: Trans. R.S.C., I, 1882-83, iv, 33; VII, 1889, iv, 69: Brit. N. A. Bound. Comm., 1875, App. A., 331: Flor. Foss. Arct., I, 1868, 138: Proc. U.S. Nat. Mus., X, 1887, 45.

Dawson gives only a reference to this plant as determined by Heer to be a constituent of the Mackenzie River flora. It has been noted by Lesquereux as occurring in the Upper Kanab valley, Utah.

Pterospermites cupanioides,(Newb.) Knowlton.

Bib: Trans. R.S.C., IV, 1886: Proc. U.S. Nat. Mus., XVI, 1893, 35: Lat. Ex. Fl., 1868, 74: U.S. Geol. Surv., Bull. 37, 1887, 94.

Newberry's only record for this species is in the Fort Union group at Glendive? Montana. The Lignite Tertiary of Porcupine creek is the only locality so far recorded for Canada.

Pterospermites spectabilis, Heer.

Bib: Trans. R.S.C., I, 1882-83, iv, 33; VII, 1889, iv, 69: Flor. Foss. Arct., II, iv, 480: Proc. U.S. Nat. Mus., XI, 1888, 27.

Dawson's reference to this species is a citation of Heer's account of its occurrence in the Tertiary beds of the Mackenzie river. Lesquereux also records it from the Miocene of Spanish peak, California.

Pyrus sp.

Bib: Geol. Surv. Can, 1877-78, 186 B.

Reference is made by Sir William Dawson to a leaf of the mountain ash, obtained from Coal gully in 1877. No similar leaves appear to have been obtained from any locality in the United States; but in the collections of Lambe from the Horsefly river in 1906 there is a single leaflet which apparently belongs to the same species as Sir William Dawson's specimen.

Quercus sp.

Bib: U. S. Geol. Surv., Bull. 204, 1902, 53, pl. VIII, f. 3: Geol. Surv. Can., 1871-72, 59; 1875-76; 1879-80; 1887, 136 E: VII, 1894, 36, 37 C: Trans. R.S.C., IV, 1886; VIII, 1890.

In the 1906 collection from the Horsefly river there were some incomplete leaves of an oak which could not be determined specifically, but which appeared to be the same as a species from Van Horne's ranch, representing the Upper Miocene of the John Day basin in Oregon, but this could not be determined with sufficient certainty.

As recorded by Sir William Dawson similar fragments of oak leaves, possibly of the same species, have been found in many localities throughout western Canada, including Quesnel, British Columbia; the Red Deer river; the Similkameen and Omineca rivers; and the Lignite Tertiary of Roche Percee, Souris river and Porcupine creek, Saskatchewan.

Quercus antiqua, Newb.

Bib: Trans. R.S.C., I, 1882-83, iv, 32; IV, 1886, iv, 27: Lat. Ex. Flor., XXXV, 1868, 26.

Dawson's reference to this oak is to show that in the Laramie beds of Canada there is a species probably allied to *Q. antiqua* of Newberry, which the latter determined to be of Dakota age, as found at Rio Dolores, Utah. The reference is therefore a doubtful one, but may indicate the same species as cited by Dawson from the Lignite Tertiary of Porcupine creek, though not named.

Quercus castanopsis, Newb.

Bib: Lat. Ex. Fl., XXXV, 7, pl. LVI, f. 4: Proc. U.S. Nat. Mus., V, 1882, 505.

Newberry records *Quercus castanopsis* from the Fort Union group of the Yellowstone river, Montana, as the only locality at present known within the United States. The species was unknown to the Canadian Tertiary until 1904, when it was brought to notice through collections from Quilchena, made by Ells and Johnston.

Quercus consimilis, Newb.

Bib: Lat. Ex. Fl., XXXV, 71, pl. XLII, f. 2-5: Proc. U.S. Nat. Mus., V, 1882, 505.

The Quilchena collection of 1906 embraced a few broken specimens, with two fairly complete leaves of *Quercus consimilis.* The only United States record for this species is from the Miocene of Bridge creek and the John Day valley, Oregon.

Quercus dallii, Lesq.

Bib: Trans. R.S.C., VIII, 1890: Proc. U.S. Nat. Mus., V, 1882, 446: Cret. and Tert. Fl. 259.

Quercus dallii was described by Newberry on the basis of specimens obtained from Cook inlet, Alaska. No other locality is known except the north fork of the Similkameen river, from which Sir William Dawson obtained specimens in 1890.

Quercus dentoni, Lesq.

Bib: Trans. R.S.C., I, 1895: Cret. and Tert. Fl., 1883, 224.

A sparingly distributed species which has been obtained by Lesquereux from the Fort Union group of the Bad Lands, Dakota, and from the Montana formation of Point of Rocks, Wyoming. The only Canadian locality at present known is Burrard inlet, British Columbia.

Quercus ellisiana, Lesq.

Bib: Trans. R.S.C., VIII, 1902, iv, 46: U.S. Geol. Surv. Terr., 1871, 297: Ter. Fl., 1878.

The Livingstone beds and the Laramie group of Bozeman, Montana, are the only United States localities known for *Quercus ellisiana.* Penhallow recorded it from the Red Deer river in 1902.

Quercus laurifolia? Newb.

Bib : Lat. Ex. Fl., XXXV, 76, pl. LIX, f. 4 : Proc. U.S. Nat. Mus., V, 1882, 505.

A single leaf from the Tulameen river is referred to *Quercus laurifolia* with some hesitation, on account of its imperfect character. It is a species which Lesquereux originally obtained from the burned shales overlying lignite beds of Fort Berthold, Dakota. It is not known beyond the very restricted distribution thus indicated.

Quercus pseudo-castanea, Goepp.

Bib : Geol. Surv. Can., 1875-76, 259-260 : Fl. Foss. Alask., 1869, 32.

Quercus pseudo-castanea is a European species which Heer has recorded from Port Graham, Alaska, in both of which localities it is regarded as of Miocene age. In 1875 Sir William Dawson observed it at the Quesnel river, British Columbia.

Rhamnacinium porcupinianum, Penh.

Bib: Trans. R. S. C., IX, 1903, iv, 48.

The only locality for *Rhamnacinium procupinianum*, which was described by Penhallow in 1903, is the Lignite Tertiary of Porcupine creek and Great valley, Saskatchewan.

Rhamnacinium triseriatim, Penh.

Bib ; Trans. R. S. C., IX., 1903, iv, 54.

Like the last, this species is known only to the Lignite Tertiary of Porcupine creek and Great valley, Saskatchewan, from which locality it was described by Penhallow in 1903.

Rhamnites concinnus, Newb.

Bib : Brit. N. A. Bound. Comm., 1875, App. A. 330 : Trans. R. S. C., I, 1882-83, iv. 32 : Lat. Ex. Flor. XXXV, 1898 118.

Sir William Dawson, in referring to this species, includes it among the specimens derived from the Lignite Tertiary of Porcupine creek, the only locality at present known in Canada. He refers it to *Rhamnus*, although Newberry's name still holds as *Rhamnites.*

Newberry's original account of this species shows that it also belongs to the Fort Union group of Fort Union, North Dakota..

Rhamnus quilchenensis n. sp.

Bib : Geol. Surv. Can. 1875-76.

In the 1906 collections from Quilchena, and also from the Horsefly river, there were a number of leaf fragments representing a species of *Rhamnus.* (Fig. 29.) Two fragments collected by Ells and Johnston in 1904 give a fairly complete idea of the general character of the leaf which is oblong, short petioled; base tapering into a margined petiole; margin remotely and finely serrate with spreading teeth.

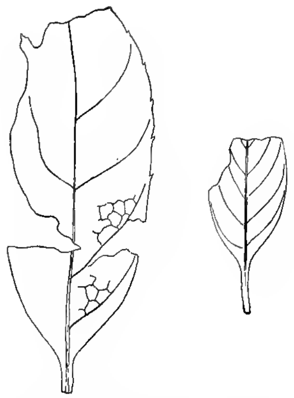

FIG. 29. *Rhamnus quilchenensis* n. sp.
Leaves from Quilchena. x 1/1.

A rhamnaceous fruit, also found in the collection of Ells and Johnston from Quilchena, seems to belong to this species.

In 1875, Sir William Dawson observed in collections from the Quesnel river a leaf of *Rhamnus* which he regarded as being near to *R. alternoides*, Heer. It is probable that this is the same as the one described as *R. quilchenensis*.

Rhamnus elegans, Newb.

Bib: Lat. Ex. Fl., XXXV, 117, pl. L. f. 2.

Rhamnus elegans has been found at Quilchena and the Horsefly river in the collections of 1906, and the specimens cannot be distinguished from Lesquereux's specimens derived from Belmont, Colorado. In assigning the horizon to this locality there appears to be some confusion in the designation. The text refers them to the Cretaceous (Laramie), while the plate description gives them as Eocene.

Rhamnus eridani, Ung.

Bib: Fl. Foss. Arct., I, 123, 153, pl. XLIX, f. 10: Fl. Tert. Helv., III, 81, pl. CXXV, f. 16: Lat. Ex. Fl. XXXV, 118, pl. XLVIII, f. 7: Proc. U. S. Nat. Mus., XI, 1888, 25.

Several fine specimens of *Rhamnus eridani* were obtained from the Tranquille river in 1906, the only locality in Canada where they have so far been found. This species is nevertheless known to the Miocene of Bridge creek, Oregon; and to the Atane beds of northern Greenland, although very sparingly distributed in all localities.

Rhamnus gaudini, Heer.

Bib: Fl. Tert. Helv., III, 79: pl. CXXIV, f. 4-15; CXXV, f. 1, 7, 13: Bost Jn'l Nat. Hist. VII, 1863, 520.

Rhamnus gaudini is a species which appears to present very great variation in size and shape. This species was originally founded by Heer on the basis of specimens collected by M. Gaudin from the neighbourhood of Lausanne.

On this side of the Atlantic it appears to occur with great rarity, the only localities at present known being at Birch bay, Washington, and Quilchena, British Columbia, as more recently determined through the collections of 1906.

Rhus rosæfolia ? Lesq.

Bib: Geol. Surv. Can., VII, 1894, 231 B: Tert. Fl. 1878, 293.

Lesquereux recorded this species from the Green River group of Florissant, Colorado, in 1878. Since then it has been noted by Sir William Dawson at Coal brook, British Columbia, but there are no further records of it.

Sabalites campbellii (Newb.) Knowlton.

Bib: Trans. R. S. C., I, 1895: Tert. Fl., 1878, 113.

As recorded by Sir William Dawson, Burrard inlet is the Canadian locality at present known for *Sabalites campbellii*, although it is somewhat abundant in the United States, being found in the Denver group of Golden, Colorado; the Fort Union group of the Yellowstone river, Montana, and the Laramie of Raton mountains and Gehrungs, Colorado.

Salix integra, Goepp.

Bib: J.S. Geol. Surv. Terr., 1873, 397: Tert. Fl., 1878, 167: T.R.S.C., I, 1895.

This somewhat rare species of willow is known to the Canadian Tertiary from Burrard inlet, as recorded by Sir William Dawson in 1895. In the United States it has been recorded by Lesquereux from Black Buttes, Wyoming; Golden, Colorado and Corral Hollow, California.

Salix kamloopsiana, Dn.

Bib; Trans. R.S.C., VIII, 1890, iv, 90.

The only record for this species is that given by Sir William Dawson in 1890, when it was obtained from Kamloops, British Columbia. The very close resemblance which it bears to *S. varians* suggests that it may be only a form of that species, more particularly as it has been found in no other collection.

Salix laramiana, Dn.

Bib: Trans. R.S.C., IV, 1886, iv, 28: Geol. Surv. Can., 1887.

Salix laramiana was first recorded by Sir William Dawson from the Lignite Tertiary of Porcupine creek in 1886, but was subsequently reported from the Red Deer river. No other localities are known.

Salix orbicularis n. sp.

In the 1904 collection of Ells and Johnston, from Quilchena, there was an imperfect specimen of a small, rounded leaf which appears to be a willow but of distinctive character. It is provisionally assigned a new name, and answers to the following description:—

Leaf orbicular, devoid of a petiole; margin entire; 16 cm wide, 1. 9 cm long. Figure 30.

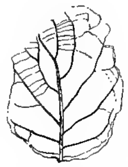

FIG. 30. *Salix orbicularis* n. sp.
Leaf from Quilchena. x 1/1.

Salix perplexa, Knowlton.

Bib : U. S. Geol. Surv., Bull. 204, 31 ; pl. II, f. 5–8.

In his account of the Flora of the John Day basin Dr. Knowlton described a willow obtained from the Miocene of Van Horne's ranch, under the name of *Salix perplexa*. In the 1906 material from Quilchena, British Columbia, there were two leaves devoid of venation, but in their general size and form they presented a closer approximation to *S. perplexa* than to any other species, and are so referred.

Salix raeana, Heer.

Bib : Fl. Foss. Arct., I.,102, 139 : Trans. R.S.C., IV, 1886.

Salix raeana, although not an abundant species, ranges from the Lignite Tertiary of Porcupine creek, Great valley and the Mackenzie river, to the Miocene of the John Day basin, Oregon, and Cook inlet, Alaska.

Salix tulameenensis n. sp.

A single example of a fruit was found in the 1906 collections from the Tulameen river (Figure 31). It bears a very close resemblance to the fruit of a willow and is therefore referred to a new species, *S. tulameenensis*. It answers to the following description :—

Fruit ovoid, 3. 5 mm broad, 41 mm long; short stalked; prolonged at the apex into a much attenuated beak.

FIG. 31. *Salix tulameenensis* n. sp.
A fruit from the Tulameen River. x 2.

Salix varians, Goepp.

Bib : Fl. Foss. Alaska, 1869, 27 : Trans. R.S.C., I, 1895, iv, 147, f. 11, : Cret. and Tert. Fl., VIII, 247, pl, LV, f. 2 : Fl. Tert. Helv. II, 27, pl. LXV, f. 1, 3, 7—16.

In 1895, Sir William Dawson obtained specimens of *Salix varians* from the Tertiary beds of Vancouver. There can be little doubt of the identity of his specimens with those originally obtained by Heer from Oeningen; and with Lesquereux's specimens from the Miocene of

Corral Hollow, Oregon, and Table mountain, California. In the more recent collections made by Lambe in 1906 the same species has been derived from the Tranquille and Horsefly rivers, and from the number of specimens obtained it would appear to have been an abundant species. Present information, however, would seem to indicate that it is a northern, rather than a southern type.

Sapindus sp.

Bib: Geol. Surv. Can., 1887; 1877-78.

In 1877, Sir William Dawson reported what he believed to be a species of *Sapindus* from Nine-mile creek on the Similkameen river, and again in 1887 what seemed to be the same form was reported from the Red Deer river. The species could not be identified, but Sir William Dawson was of the opinion that its affinities were with *S. angustifolius*, Lesq.

Sapindus affinis, Newb.

Bib: Trans. R. S. C., IV, 1868; Lat. Ex. Fl., 1868, 51.

Sapindus affinis was first noticed by Newberry in the Fort Union group of Gladstone, Dakota. It was subsequently observed by Sir William Dawson in the Lignite Tertiary of Porcupine creek and Great valley, Saskatchewan. No other localities have been recorded.

Sassafras sp.

A fragmentary leaf was obtained by Ells and Johnston from Quilchena, in 1904. It is too incomplete for satisfactory identification, but appears to be a species of *Sassafras*.

Sassafras burpeana, Dn.

Bib: Trans. R. S. C., III, 1885; IV, 1868.

The only localities known for *Sassafras burpeana* are those recorded by Sir William Dawson from the Lignite Tertiary of Calgary, Alberta, and Porcupine creek, Saskatchewan.

Sassafras selwynii, Dn.

Bib: Geol. Surv. Can., 1879-80, 53 A: Trans. R. S. C., IV, 1886, iv, 28.

So far as known, *Sassafras selwynii* is wholly characteristic of the Lignite Tertiary of Roche Percee, Souris river and Porcupine creek, Saskatchewan.

Scirpus sp.

Bib: Trans. R. S. C., IV, 1886.

Dawson records two forms of leaves from the Lignite Tertiary of Porcupine creek, which he regards as distinct species of *Scirpus*, but he does not attempt to describe them specifically.

Sequoia sp.

Bib: Trans. R. S. C., VIII, 1890.

In many of the Tertiary collections there are found fragments of cones and inflorescence which appear to belong to some species of *Sequoia*, but they are too much fragmented and

otherwise altered to make their relationship clear. Such were noted by Sir William Dawson in collections from the Tranquille and Coldwater rivers in 1890, and similar remains have since appeared in collections from Quilchena. and from both the Tulameen and Horsefly rivers.

Sequoia angustifolia, Lesq.

Bib : U. S. Geol. Surv. Terr., 1872, 372 : Tert. Fl., 1878, 77, 138 : Cret. and Tert. Fl., 1883, 240.

Sequoia angustifolia is a very well characterized species which Lesquereux has observed in the Green River group of Elko station, Nevada; at Black Buttes, Wyoming, and in the Miocene of Florissant, Colorado, and Corral Hollow, California. He directs attention to the close resemblance it bears to *Torrey californica.*

In Canada it has been found sparingly at Quilchena, and at the Similkameen, Horsefly and Tulameen rivers. So far as present information permits of such a conclusion, it seems to centre at the Tranquille river, from which numerous specimens have been obtained.

Sequoia brevifolia, Heer.

Bib: Geol. Surv. Can., 1877-78, 186 B: Fl. Foss. Arct., I, 93, pl. II, f. 2-3 : Tert. Fl., VII, 78, pl. LXI, f. 25-27 : U.S. Geol. Surv. Terr., 1874, 298; 1875, I, 365.

The Montana formation at Point of Rocks, Wyoming, appears to be the most southern extension of *Sequoia brevifolia.* From there it ranges north to Greenland, where it appears in the Atane beds.

In Canada it has been recorded by Sir William Dawson from Nine-mile creek, on the Similkameen river, and more recently the collections of 1906 have shown it to belong to the floras of the Tulameen and Tranquille rivers, from both of which well preserved specimens have been obtained.

Sequoia burgessii, Penh.

Bib : Trans. R.S.C., IX, 1903, iv, 39 : N. A. Gymnosperms, 1907.

This species is known through its wood only, and at present there is only one station—the Lignite Tertiary of Porcupine creek, Saskatchewan, as recorded by Penhallow in 1903.

Sequoia couttsiæ, Heer.

Bib : Trans. R.S.C., VIII, 1902, iv, 46, 50 : Geol. Surv. Can., 1887 : N. Y. Acad. Sc.. XII, 1892, 30.

This somewhat rare species of *Sequoia* has been observed by Hollick in the Cretaceous of Staten island, New York, but elsewhere it appears to be a feature of the Tertiary. The only locality known for the United States is that given above. In Canada it has been observed at the Red Deer river, from which it was obtained by Sir William Dawson in 1887, and by Lambe in 1897; and from the Finlay and Omineca rivers as recorded by Sir William Dawson in 1894. It is chiefly represented by the foliage, but the collections of Lambe in 1897 contain fragments of *Sequoia* cones which are believed to belong to this species.

Sequoia heerii, Lesq

Bib: U.S. Geol. Surv. Terr., 1871, 290: Tert. Fl., 1878, 77: Cat. Cret. and Tert. Pl., 217.

Sequoia heerii is abundantly represented in the Tertiary formation of Canada, and its occurrence at Quilchena, and the Horsefly and Tranquille rivers, would seem to imply its very general distribution throughout the Tertiary beds. Only the foliage is known with certainty, but in the material from the Tulameen river some of the specimens were preserved in a very perfect manner (figure 32).

FIG. 32. *Sequoia heerii*, Lesq.
Leaves from Tulameen River. x 1/1.

The Green River group of Sage creek, Montana, is the only locality recorded for the United States, from which it would seem probable that the species represents a northern type.

Sequoia langsdorfii, (Brongn.) Heer.

Bib: Trans. R.S.C., VIII, 1890, 80, f. 8; VIII, 1902, iv, 68; VII, 1889; IX, 1903, 33: Geol. Surv. Can., 1877-78, 186 B; 1887; 1875-76; 1888-89; VII, 1904, 36, 37 C: Cret. and Tert. Fl., VIII, 138, 223, 240: Tert. Fl., VII, 1878, 76: Fl. Tert. Helv., 1, 54.

Sequoia langsdorfii is the most widely distributed and most abundant species of *Sequoia* in North America. Lesquereux has made known its occurrence in the Miocene of the John Day valley, Oregon; the Bad Lands of Dakota and Corrall Hollow, California; Black Buttes, Wyoming, and the Green River group of Florissant, Colorado.

The earliest Canadian record is that of Sir William Dawson in 1875, who obtained it from the Blackwater river, British Columbia. Since then he has obtained it from Nine-mile creek on the Similkameen river; the Red Deer, Finlay and Omineca rivers. In all of these cases the tree was represented by foliage, but in 1888 he notes the occurrence of wood at the Bear river, Mackenzie basin, and regards it as the same as that originally determined by Schroeter to be a species of *Sequoia*.

Subsequent collections in 1902 have confirmed the occurrence of this species at Red Deer river, and Penhallow has recorded certain woods from the Lignite Tertiary of Porcupine creek, which he regards as belonging to the same species.

Sequoia nordenskioldii, Heer.

Bib: Geol. Surv., 1887: Trans. R.S.C., IV, 1886; VIII, 1902, 33: Lat. Ex. Fl., XXXV, 20, pl. XXVI, f. 4: Proc. U.S. Nat. Mus., XI, 1888, 19: Fl. Foss. Arct., II, 36, pl. II, f. 13, pl. IV, f. la, b, 4–38.

This well known and well characterized species has much the same distribution as *S. heerii*. It has been recorded from the Yellowstone river in Montana, and from the Miocene of the John Day valley, Oregon.

In Canada it was first known to the Lignite Tertiary of Porcupine creek and Great valley, and to the Mackenzie river, but it has since been obtained from the Horsefly river, and on two occasions from Quilchena.

Sphenopteris blœmstrandi, Heer.

Bib: Trans. R.S.C., VIII, 1902, iv, 48: Mioc. Fl. Greenland, 1874, 18, pl. I, f. 3–5: Mioc. Fl. Spitz., 1870, 31.

This species is unknown to the Tertiary of the United States, and there was no Canadian record until 1902, when Penhallow noted its occurrence in the Tertiary beds at Red Deer river. It has not been observed since that time.

Sphenopteris guyottii, Lesq.

Bib: Trans. R.S.C., VIII, 1902, 48: Cret. and Tert. Fl., VIII, 137.

Evidently an unusual species recorded for only two localities—the Green River group of Florissant, Colorado, and the Red Deer river, Alberta.

Sphenozamites? oblanceolatus n. sp.

Bib: Font. Old. Mes. Fl. Va., U.S. Geol. Surv., VI, 80, pl. XLIII, XLIV, XLV: Trans. R.S.C. VIII, 1902, iv, 63, f. 11.

Collections from the Red Deer river in 1897 contained a single fragment of a broad leaf which answers to the following description:—

Leaf oblanceolate?, 16? cm wide, tapering to a narrow base, the insertion of which is not shown; margin entire; venation parallel, fine, the veins 22–30 per cm.; transverse bars distant about 1.5 mm.

The general aspect of this very imperfect fragment strongly suggests *Sphenozamites rogersianus*, from which it appears to differ in shape and the greater remoteness of the transverse bars of the venation. It has, therefore, been thought expedient to give it a distinctive name.

Symphorocarpophyllum sp.

Bib: Trans. R.S.C., IV, 1886.

A fragment of a leaf from the Lignite Tertiary of Porcupine creek was referred to this genus in 1886, without any specific designation.

Symphorocarpophyllum albertum Dn.

Bib: Trans. R.S.C., IV, 1886, iv, 30.

The only Canadian locality for this species is that recorded by Sir William Dawson in 1886, for the Laramie formation of Porcupine creek, Saskatchewan.

Symphorocarpophyllum linnæiforme, Dn.

Bib: Trans. R. S. C., IV, 1886, iv. 30.

This species was found with the preceding, and has precisely the same geological and geographical range.

Taxites olriki, Heer.

Bib: Trans. R. S. C., IV, 1886, iv, 23. f. 5: Geol. Surv. Can., 1879-80; N. Ser. IV, 1888-89: Trans. R. S. C., VII, 1889: Fl. Foss. Arct., I, 95: Cret. and Tert. Fl., 1883, 240.

Taxites olriki has been reported several times by Sir William Dawson, in collections from the Lignite Tertiary of the Mackenzie river, Roche Percee, Souris river and Porcupine creek, Saskatchewan. It has more recently appeared in the collections from Quilchena where it is represented by detached pinnae. The only United States locality, so far on record, is the Miocene of Corral Hollow, California.

Taxodium distichum miocenum, Heer.

Bib: Harriman Alaska Exp., IV, 1904, pl. XXII–XXXIII, p. 149-162: U. S. Nat. Mus. XVII, 1894, 214: U. S. Geol. Surv. Terr., VIII, 1883, 139, 223; VII, 1878, 73: Fl. Tert. Helv., I, 49: Trans. R. S. C., VIII, 1890, iv, 79; IX, 1903, iv, 36; VIII, 1902, iv, 68: Geol. Surv. Can., 1875-76; 1877-78.

This exceedingly common and very abundant species is found in all Tertiary collections so far brought together from Canadian localities. It is also known to the Fort Union group of Montana; the Miocene of the John Day basin, Oregon, and to the Eocene of Elko station, Nevada, Carbon and Evanston, Wyoming. Its extension to Alaska and Greenland shows that it was a very wide spread form, and this may explain in part the somewhat great diversity in the character of the foliage generally referred to *T. distichum miocenum*, but which merges with the specific form, from which it can be distinguished with difficulty in many cases.

Taxodium laramianum, Penh.

Bib: Trans. R. S. C., X. 1904, iv, 57.

This species was obtained in the form of wood, from the Lignite Tertiary of Cochrane, Alberta, in 1887. No foliage of fruits has yet been found.

Taxodium occidentale, Newb.

Bib: Lat. Ex. Fl., XXXV, 23: Trans. R. S. C., IV., 1886, iv, 23: Geol. Surv. Can. 1875-76; 1887.

This beautiful and very well characterized species has been reported by Lesquereux from the Fort Union group of the Yellowstone river in Montana, but it does not appear to be elsewhere known in the United States.

In Canada it was first reported by Heer as contained in the collections of Sir John Richardson, who also gives a very fine figure of it in his journal of the Searching Expedition. In 1879 it was reported by Sir William Dawson from the Lignite Tertiary of Roche Percee, Souris river, and since then it has appeared in nearly all Tertiary collections. In 1897 Lambe obtained it from the Red Deer river, from which locality it had also been obtained by Dawson in 1887. In 1904 it appeared in the collections of Ells and Johnston from Quilchena. The more recent collections of Lambe in 1906 show that it is also found in the deposits of the Similkameen, Tranquille and Horsefly rivers. Its recognition by Dawson, in the Tertiary of Porcupine creek and Blackwater river, affords evidence of a very wide distribution, and the fact that while it is a very well defined type in the Lignite Tertiary, it is also very characteristic of the Miocene.

Taxus sp.

Bib: Geol. Surv. Can., 1873-74, 51.

A specimen of wood collected from the Edmonton coal beds in 1873 was referred by Sir William Dawson to an undetermined species of *Taxus.* There has been no further opportunity to study this material more fully.

Thuya interrupta, Newb.

Bib: Lat. Ex. Fl., 1868, 25, 42; pl. XXVI, f. 5-5d: Geol. Surv. Can., 1877-78, 186 B; 1875-76: Trans. R.S.C., IV, 1886, iv, 22; X, 1904, iv, 57.

Thuya interrupta is represented in various Tertiary collections by fragments of leafy branches which often bear inflorescence or fruit. They were noted by Sir William Dawson in the Blackwater river as early as 1875, and since then he obtained them from Nine-mile creek on the Similkameen, and from the Lignite Tertiary of Porcupine creek.

In 1904, Penhallow observed a wood from Porcupine creek which he regarded as a species of *Thuya,* and it may prove to be *T. interrupta.* Further collections by Ells and Johnston in 1904, and by Lambe in 1906, have shown this species to be a constituent of the flora of Coal brook, and also of Quilchena, where it is found in abundance.

The only United States locality appears to be the Fort Union group of North Dakota, but it is evident that it had a wide distribution, that it was a somewhat abundant type, and that it ranged from the Lignite Tertiary through the Miocene.

Trapa borealis, Heer.

Bib: Fl. Foss. Alask., 1869, 38: N. A. Bound. Comm., 1875, App. 330: Trans. R.S.C., IV, 1886.

This species, first observed by Heer in Alaska, does not seem to be on record for any locality in the United States, but is practically confined to Canada where it has been recorded from the Lignite Tertiary of Porcupine creek.

Trapa? microphylla, Lesq.

Bib: Trans. R.S.C., IV, 1886: U. S. Geol. Surv. Terr., 1875, I, 369; 1874, 304: Tert. Fl., 1878, 295: U. S. Geol. Surv., Bull. 37, 1887, 64.

The forms which were originally referred by Lesquereux to the genus *Trapa*, under the name of *T. microphylla*, are somewhat abundant in Canada, and particularly in the United States. In the former they are met with in the Lignite Tertiary of Porcupine creek, and they have also been observed in the Red Deer and Rosebud rivers, as well as at Pincher creek. In the United States they are features of the Fort Union group at Burn's ranch, Montana; the Laramie of Converse county, Wyoming, and the Montana group at Point of Rocks, Wyoming.

Typha sp.

Bib: Trans. R.S.C., VIII, 1902, iv, 46.

Specimens of leaves from the Red Deer river have been referred to the genus *Typha* as representing their nearest affinity.

Typha latissima, A. Br.

Bib: Cret. and Tert. Fl., 1883, 141, pl. XXIII, f. 4, 4*a*: Fl. Tert. Helv., I, 98, pl. XLIII XLIV.

The broad leaved plants, usually represented wholly by leaf fragments, and originally designated by Heer as *Typha latissima*, are common features of Tertiary collections.

In the United States they are known to the Green River group of Uinta county, Wyoming. In Canada they have been found somewhat abundantly in the Tertiary beds of Coal gully; and the Tranquille, Horsefly and Tulameen rivers, as indicated by Lambe's collections of 1906.

Ulmus sp.

Bib; Trans. R.S.C., XIII, 1907, iv.

In the collection of Ells and Johnston from Coal gully in 1904 there was a leaf of an elm, very probably that of *U. speciosa*. What may be the same leaf was again found at Kettle river by Daly in 1906. In Lambe's collection from the Tulameen in 1906 there were various fruits which appeared to belong to an elm, and they are provisionally associated with *U. speciosa*.

Ulmus columbiensis, Penh.

Bib: Trans. R.S.C., XIII, 1907, iv.

Daly's collection in 1905 included specimens of wood of an elm which at present cannot be correlated with any existing species. The description of this wood appears in a report on Daly's collections as published in the Transactions of the Royal Society of Canada for 1907. The Kettle river is the only locality so far known for it.

Ulmus minuta, Goepp.

Bib: Fl. Tert. Helv., II, 59, pl. LXXIX, f. 9–10, 26, 27: Trans. R.S.C, VIII, 1890, iv, 88, f. 23, 24: Lat. Ex. Fl., pl. XLV, f. 7.

In the collections of Lambe, made in 1906, there were several very well preserved specimens of elm leaves of very small size. They were found at both the Horsefly and the

Tulameen rivers. A close comparison with Dawson's *U. pusillus* from the Tulameen river leads to the belief that the two are identical.

In Lambe's collection from the Horsefly river in 1906 there were a few specimens of a very small fruit, evidently that of an elm. Comparison with fruits figured by Heer shows that there can be no possible relation to *U. speciosa*, Newb., and that it is much smaller than any of the fruits illustrated by Heer. It answers to the following description:—

Wing broadly elliptical, 3.75 x 3 mm, incomplete; marked by numerous radiating veins. Fruit ovate, acuminate, 1 mm broad, 1.75 mm long. It has the striation of *U. speciosa* but is far too small to be it. (Fig. 33).

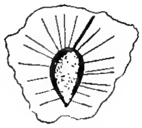

Fig. 33. *Ulmus minuta*, Goepp.
A fruit from the Horsefly River. x 5.

It seems probable that this may be the fruit of *U. minuta*, and it is so referred for the present.

Ulmus proto-americana, Penh.

Bib : Trans. R.S.C., XIII,1907, iv.

In material from the Kettle river, collected by Dr. Daly in 1905, there were specimens of wood which, from their somewhat close resemblance to *U. americana*, have been designated as *U. proto-americana*. It is quite possible that either this or the next may be the wood of *U. speciosa*.

Ulmus proto-racemosa, Penh.

Bib : Trans. R.S.C., XIII, 1907, iv.

This wood was associated with *U. proto-americana* in the deposits of the Kettle river. It bears a very close resemblance to the existing *U. racemosa*.

Ulmus speciosa, Newb.

Bib: Proc. U.S. Nat. Mus., V., 1882, 507: Lat. Ex. Fl., XXXV, 80, pl. XLV, f. 2–8: Cret. and Tert. Fl. VIII, 249, pl. LIV, fl. 10.

Ulmus speciosa was first described by Newberry who recognized its close relation to *U. americana* which he says it is in all its essential characters, though he preferred to recognize it as the specific type. Knowlton, however, in dealing with material from the John Day basin, considered that there was too great variation in size for all of them to be included under the same species, and he therefore separates the smaller under the name of *U.newberryi*. *U.speciosa* has been recognized in the Miocene of the John Day basin and Bridge creek, Oregon, and in Canada it appears in the Tertiary beds of Coal gully, Quilchena and the Horsefly river.

Ulmus tenuinervis, Lesq.

Bib: U. S. Geol. Surv. Terr., 1873, 412: Tert. Fl. VII, 188, pl. XXVI, f. 1-3: Trans. R.S.C., IV, 1886, iv. 28, pl. II, f. 11: Cat. Cret. and Tert., Pl., 1898, 236.

In 1886, Sir William Dawson described certain well preserved leaves of an elm under the name of *Ulmus præcursor*. They were obtained from the Lignite Tertiary of Porcupine creek and were regarded as closely related to *U. tenuinervis*, Lesq. Knowlton has ascertained that the two are really identical, in consequence of which Dawson's species is abandoned.

In the collections of Lambe from the Tranquille river in 1906 this species is again found, but it has not appeared in any collection other than those indicated.

Vaccinophyllum questum, Dn.

Bib: Trans. R. S. C., VIII, 1890, iv, 88.

The only locality at present known for this species is the Miocene of the Similkameen river, from which it was obtained by Sir William Dawson in 1890.

Viburnum asperum, Newb.

Bib: Geol. Surv. Can. 1887: VII, 1894, 36, 37 C: Lat. Ex. Fl., 1868, 54.

First recorded by Newberry from the Fort Union group of Cracker-box and Seven-mile creeks, Montana, and the Bad Lands of Dakota, *Viburnum asperum* was later obtained by Sir William Dawson from the Lignite Tertiary of Porcupine creek and from the Red Deer, Finlay and Omineca rivers, but it has not been observed since 1894.

Viburnum calgarianum, Dn.

Bib: Trans. R. S. C, III, 1885, iv, 18; IV, 1886, iv, 26.

Sir William Dawson originally obtained this species from the Lignite Tertiary of Calgary, Alberta, and in 1886 observed its occurrence in the same horizon at Porcupine creek. It has not been found elsewhere, or since that date.

Viburnum dentoni, Lesq

Bib: Cret. and Tert. Fl., VIII, 231, pl. XLIX, f. 2-3.

The original description of this species by Lesquereux was based upon fragments of leaves obtained from the Fort Union group of the Bad Lands, Dakota. Its first record since that date is to be found in the present statement of its occurrence in the Tertiary beds of the Tranquille river, as shown by the collections of Lambe in 1906.

Viburnum lakesii, Lesq.

Bib: Trans. R. S. C., I, 1882-83, iv, 32: U. S. Geol. Surv. Terr. 1873, 410: Lesq. Tert. Flor. 1878, 226.

The only Canadian account of this *Viburnum* is to be found in Sir William Dawson's Cretaceous and Tertiary Flora for 1882, in which he makes a simple reference to its occurrence. Lesquereux has determined its presence in the Denver group of Golden, Colorado.

Viburnum lanceolatum, Newb.

Bib: Trans. R. S. C., IV, 1886: Lat. Ex. Fl., 1868, 54.

There is only one record of this species from Canada, as contained in Sir William Dawson's account of its occurrence at Porcupine creek; but it has been recorded by Newberry for the Fort Union group of Fort Union, North Dakota.

Viburnum ovatum, Penh.

Bib: Trans. R. S. C., VIII, 1902, iv. 46.

This apparently distinctive form of leaf was obtained from the Red Deer river in 1897 as recorded by Penhallow, but it has not been found since then, either in the same locality or elsewhere.

Viburnum oxycoccoides, Dn.

Bib: Trans. R.S.C., III, 1885, iv, 17; IV, 1886, iv, 29.

Viburnum oxycoccoides has been observed in the Lignite Tertiary of Porcupine creek and of Calgary, Alberta, but it has not appeared in any collection since 1886. It is not known in the United States.

Viburnum pubescens, Pursh.

Bib: Brit. N. A Bound. Comm., 1875, App. A. 330: Trans. R.S.C., I, 1882, iv, 32.

The original account of this plant was published by Sir William Dawson in 1875, in his account of the Lignite Tertiary plants of the 49th parallel. It has not been observed since that time.

Viburnum saskatchuense, Dn.

Bib: Geol. Surv. Can., 1887: Trans. R.S.C., V, 1887, iv, 35.

The Red Deer river in 1887, and the North Saskatchewan in the same year, are the only two localities so far known for this species, the horizon of which is Miocene.

Vitis olriki ? Heer.

Bib: Tert. Fl., VII, 241, pl. XLI, f. 8: Fl. Foss. Arct., I, 120: U. S. Geol. Surv. Terr., 1871, supp. 12.

An imperfect specimen of a leaf from the Horsefly river, contained in Lambe's collection of 1906, is referred with hesitation to *Vitis olriki*, a well known species also found in the Denver group of Mount Bross, Middle park, Colorado; and in the Laramie of Evanston, Wyoming and Raton mountains, New Mexico.

Vitis rotundifolia ? Newb.

Bib: Lat. Ex. Fl., XXXV, 120, pl. LI, f. 2, LII, f. 3: Proc. U. S. Nat. Mus., V, 1882, 513.

One imperfect specimen of what appeared to be *Vitis rotundifolia* was obtained by Lambe from Quilchena in 1906, but it has not been obtained elsewhere in Canada; and Admiralty inlet, Alaska, is the only other station so far on record.

Zanthoxylum spireæfolium, Lesq.

Bib : Cret. and Tert. Fl., VIII, 196, pl. XL, f. 1-3 : Fl. Tert. Helv., III, 85, 96.

This species as originally described by Newberry has been found in only two localities in North America, although it had been incorrectly compared by Newberry with *Z. juglandium* and *Z. serratum* of Heer, as obtained from the Tertiary of Europe. In 1883, Newberry obtained it from the Green River group of Florissant, Colorado, and in 1906 Lambe found it at Quilchena.

Lists of Tertiary Plants, collected by Mr. L. M. Lambe in 1906 from various localities in British Columbia.

Specimen number.	
	COAL GULLY.
5.	*Phragmites* sp.
8.	*Populus acerifolia*, Newb.
7.	*polymorpha*, Newb.
3.	*Sequoia langsdorfii*, (Brongn.) Heer.
9.	Stems of undeterminable character.
2.	*Taxodium distichum miocenum*, Heer.
6.	*Thuya interrupta*, Newb.
4.	*Typha latissima*, A. Br.
1.	*Ulmus speciosa*, Newb.
	HORSEFLY RIVER.
2, 3, 21.	*Acer* sp.
31.	*trilobatum productum*, Heer.
26.	*Alnus carpinoides*, Lesq.
35.	*Carex* sp.
33.	*Carpolithes* sp.
37.	*dentatus*, Penh.
39.	*Carya antiquorum*, Newb.
40.	*Corylus americana*, Walt.
22.	*macquarrii*, (Forbes). Heer.
19.	*Cinnamomum affine*, Lesq.
30.	*Cratægus tranquillensis* n. sp.
52.	*Cupressoxylon dawsoni*, Penh.
12.	*Cyperites* sp.
48.	*Ficus* sp.
25.	*asarifolia ?* Ett.
18, 44.	*populina*, Heer.
4, 36.	*Gingko adiantoides*, (Ung.) Heer.
11.	*Glyptostrobus europæus*, (Brongn.) Heer.
16.	*Grewia crenata*, (Ung.) Heer.
29.	*Juglans occidentalis*, Newb.
24.	*Leguminosites ? arachioides*, Lesq.
47.	*Myrica* sp. ?
46.	*personata ?* Knowlton.
28.	*Onoclea sensibilis*, L.
32.	*Pinus* sp.
51.	*Pinus* sp.
17.	*trunculus*, Dn.

Specimen number.	
41.	*Planera crenata*, Newb.
6.	*longifolia*, Lesq.
50.	*Populus* sp.
5, 20,	*latior*, A. B.
43.	*Quercus* sp,
34.	*Rhamnus quilchenensis* n. sp.
27, 29.	*Salix varians*, Goepp.
10.	*Sequoia angustifolia*, Lesq.
8.	*heerii*, Lesq.
9.	*nordenskioldii*, Heer.
42.	*Taxodium* sp.
7.	*distichum miocenum*, Heer.
53.	*laramianum*, Penh.
13.	*occidentale*, Newb.
14.	*Typha latissima*, A. Br.
1, 38.	*Ulmus minuta*, Goepp.
15.	*speciosa*, Newb.
45.	Undeterminable material.
23.	*Vitis olriki ?* Heer.

QUILCHENA.

15.	*Alnites curta*, Dn.
59.	*Alnus* sp.
41.	*serrulata fossilis*, Newb.
37.	*Amygdalus gracilis*, Lesq.
11.	*Aralia acerifolia*, Lesq.
50.	Branch of dicotyledonous plant.
47.	*Carpinus* sp.
10.	*grandis*, Ung.
16.	*Carpolithes dentatus*, Penh.
20.	*Carya antiquorum*, Newb.
36.	*Castanea intermedia*, Lesq.
52.	*Comptonia dryandroides*, Eng.
53.	*quilchenensis* n. sp.
51.	Cone fragment.
33.	*Cornus suborbifera ?* Lesq.
26, 35.	*Corylus americana*, Walt.
22.	*Cyperites* sp. Stem.
43.	*Dryophyllum stanleyanum*, Dn.
57.	*Ficus decandolleana*, Heer.
38.	*ungeri*, Lesq.
8, 32.	*Gingko adiantoides*, (Ung.) Heer.
5.	*Glyptostrobus europæus*, (Brongn.) Heer.
7.	*Pinus lardyana*, Heer.
9, 18.	*steenstrupiana*, Heer.
12, 13, 23.	*trunculus*, Dn.
30.	*Populus acerifolia*, Newb.
19.	*cordata*, Newb.
25.	*genetrix*, Newb.
39.	*mutabilis oblonga*, Heer.
17.	*nebrascencis*, Newb.

Specimen number.	
14.	*Populus obtrita*, Dn.
61.	*Prunus merriami*, Knowlton.
27.	*Quercus consimilis*, Newb.
29.	*Rhamnus elegans*, Newb.
31.	*gaudini*, Heer.
40.	*quilchenensis* n. sp.
58.	*Salix perplexa*, Knowlton.
54.	*varians*, Goepp.
49.	Sedge ? Fruit.
55.	*Sequoia* sp.
4.	*angustifolia*, Lesq.
3, 56.	*heerii*, Lesq.
2,	*nordenskioldii*, Heer.
21.	Stems. Fragments of unknown character.
42, 45.	*Taxites olriki*, Heer.
1, 48.	*Taxodium distichum miocenum*, Heer.
60.	*occidentale*, Newb.
6.	*Thuya interrupta*, Newb.
24.	*Typha* sp.
28.	*Ulmus speciosa*, Newb.
34.	*Vitis rotundifolia ?* Newb.
46.	*Zanthoxylum spireæfolium*, Lesq.

SIMILKAMEEN VALLEY.

12.	*Betula* sp.
9.	*Carpinus grandis*, Ung.
14.	*Carya antiquorum*, Newb.
1e, 4,	*Comptonia diforme*, (Sternb.) Berry.
10.	*dryandroides*, Ung.
18.	Cones ?
6.	*Cyperites* sp.
11.	*Nelumbium pygmæum*, Dn.
3.	*Osmunda heerii*, Gaudin.
5.	*Phragmites* sp.
1a.	*Populus obtrita*, Dn.
13, 16.	*rotundifolia*, Newb.
15.	*zaddachi*, Heer.
8.	Rhizomes.
17.	*Sequoia acuminata ?* Lesq.
1.	*Taxodium distichum miocenum*, Heer.
1d.	*occidentale*, Newb.

TRANQUILLE RIVER.

13.	*Alnus carpinoides*, Lesq.
39.	*Andromeda delicatula*, Lesq.
38.	*Betula* sp.
34.	*heterodonta*, Newb.
9, 35.	*macrophylla*, Goepp.
14.	*Carpinus grandis*, Ung.
41.	*Carpolithes* sp.
11.	*dentatus*, Penh.

Specimen number.	
33.	*Carya antiquorum*, Newb.
21.	*Cinnamomum affine*, Lesq.
18.	*Corylus americana*, Walt.
20.	*Cratægus tranquillensis* n. sp.
25.	*Cyperites* sp.
40.	*Ficus asiminæfolia*, Lesq.
3, 4,	*Gingko adiantoides*, (Ung.) Heer.
22.	*Glyptostrobus europæus*, (Brongn.) Heer.
37.	*Juglans rhamnoides*, Lesq.
12.	*Picea tranquillensis* n. sp.
24.	*Pinus* sp. Cone.
1, 4, 27.	*trunculus*, Dn.
28.	*Planera longifolia*, Lesq.
16.	*Populus acerifolia*, Newb.
19.	*cuneata*, Newb.
10.	*mutabilis oblonga*, Heer.
32.	*zaddachi*, Heer.
36.	*Rhamnus eridani*, Ung.
29.	Roots.
30.	*Salix varians*, Goepp.
4, 7,	*Sequoia angustifolia*, Lesq.
42.	*brevifolia*, Heer.
8.	*heerii*, Lesq.
6.	*langsdorfii*, (Brongn.) Heer.
26.	Stems. Herbaceous.
23.	Stems. Dichotomous.
2, 4.	*Taxodium distichum miocenum*, Heer.
5.	*occidentale*, Newb.
31.	*Typha latissima*, A. Br.
17.	*Ulmus tenuinervis*, Lesq.
15.	*Viburnum dentoni*, Lesq.

TULAMEEN RIVER.

16, 19.	*Acer* sp.
45.	*Æsculus* sp.
35.	*Alnus alaskana*, Newb.
33.	*Betula* sp. Cones.
34.	*Carpinus grandis*, Ung.
41.	*Carpolithes* sp.
13.	*Cinnamomum affine*, Lesq.
24.	*Comptonia diforme*, (Sternb.) Berry.
37.	*Cornus suborbifera?* Lesq
8.	*Cratægus tulameenensis* n. sp.
7, 23.	*Cyperites* sp.
17.	*Ficus asiminæfolia*, Lesq.
36.	*populina*, Heer.
15.	*Gingko* sp.? Fruit.
18.	*adiantoides*, (Ung.) Heer.
1, 14.	*Glytostrobus europæus*, (Brongn.) Heer.
25.	*Magnolia* sp.

Specimen number.	
27.	*Musophyllum complicatum*, Lesq.
43.	*Pinus* sp. Seed.
44.	sp. Scale of the cone.
21, 20.	*trunculus.*
22.	*tulameenensis.*
9.	*Planera longifolia.*
32.	*Populus arctica.*
29.	*cordata.*
28.	*cordifolia.*
31.	*cuneata.*
12.	*latior.*
11.	*zaddachi.*
26.	*Potamogeton verticillatus.*
30.	*Quercus laurifolia.*
46.	Roots. Fine and thread-like.
4.	*Sequoia* sp.
2.	*angustifolia.*
3.	*heerii.*
5.	*langsdorfii.*
6.	*Taxodium distichum miocenum.*
42.	*Typha latissima.*
10.	*Ulmus* sp. Fruit.
40.	*minuta.*
38.	Various metamorphosed clays and sandstones containing unrecognizable and mostly carbonized fragments of leaves, stems and fruits.

DISCUSSION OF THE FLORA.

In discussing the Tertiary flora presented in these studies, the leading questions offered for solution are —

1. The general distribution in western Canada, as between the Eocene and the Miocene, as well as the geographical range of each.

2. The more special horizon of the Miocene plants, with respect to their location in the Miocene proper.

It should be pointed out in the first place that the results derived from the collections made by Lambe in 1897 and 1906, as well as those of Ells and Johnston in 1904, when added to those of previous collectors, chiefly Heer and Dawson, show a total of 271 species and genera as entering into the entire Tertiary flora of Saskatchewan, Alberta, the North-West Territories and British Columbia. A few species known to the United States, but heretofore unknown within Canadian limits, have been found to occur within the more northern area, but this number is inconsiderable. The more recent collections referred to have added only ten new species or 3.7 per cent to the flora as already known—a surprisingly small proportion when we recall the vast extent of the territory from which specimens have been derived, and the further fact that in most of the recent collections from other regions there has been a much higher percentage of new forms. This would seem to indicate that the various plant beds from which collections have been made were examined somewhat

exhaustively. Whether this be the case or not, it is certainly true that since the earlier collections studied by Sir William Dawson there have been but few additions recorded by observers of later date.

Upon inspecting the tables of stratigraphical distribution from page 112 *et seq* it is to be observed that a great number of species have been derived from a number of different localities, often widely separated, and this serves to indicate that substantially the same flora extended throughout the entire area in each of the two deposits, Eocene and Miocene.

According to previously obtained knowledge, the entire Tertiary flora may be divided into two groups, the one distinctively Eocene, the other presumbly Miocene or Oligocene, and it will be the purpose of the present studies to define these more exactly and ascertain the extent of their commingling, as well as to correlate new localities with those previously studied.

With respect to the general regional distribution of these two floras, it was pointed out by Sir William Dawson some years since, that "both in British Columbia and east of the Rocky mountains, the Cretaceous proper is overlaid by newer beds. West of the Rocky mountains these assume the form of old lake beds filled with fresh water deposits holding remains of insects and plants. East of the mountains, on the other hand, the undoubted Cretaceous beds of the Fort Pierre and Fox Hills groups are covered by a widely extended series of clays and sandstones, holding fossil plants and lignite, with brackish water and fresh water shells. This is known as the Laramie, Lignite or Fort Union group. To this belong the plants from Porcupine creek and the Souris river[1], the plants described by Heer from the Mackenzie river, and those of the Fort Union beds of the Upper Missouri described by Newberry and others. They constitute the Lower Tertiary or Lignitic Tertiary of Lesquereux."

The evidence derived from more recent studies shows that the general conclusions thus reached are, in the main, correct, but it will also be seen that lignite areas lie within portions of British Columbia where they were not supposed to exist or where they were not clearly defined.

THE EOCENE.

It is unnecessary at this time to review in detail all the evidence which has been brought to bear from time to time to show that the Tertiary beds east of the Rocky mountains are, so far as now known, of Eocene age, since with the possible exception of the Red Deer river, but partially explored by the earlier collectors, the Eocene character of the formation has been well established for several years. But even in the case of the Red Deer river itself, the evidence derived from collections made by Weston in 1889, and fully reported upon in 1902[2], has shown that this locality must also be included in the Lignite Tertiary, both because of its flora and its stratigraphical relations.

It therefore remains only to direct attention to and emphasize certain facts about which uncertainty appears to exist in some quarters.

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1 Trans. R.S.C., I, 1882-83, iv, 29-34.
2 Trans. R.S.C., N. S., VII, 1902, iv, 46.

The Canadian Eocene is known through the following localities;—

1 Souris river.
2 Great valley.
3 Porcupine creek.
4 Saskatchewan river : all in the Province of Saskatchewan.
5 Calgary.
6 Cochrane.
7 Red Deer river.
8 Edmonton : all in the Province of Alberta.
9 Mackenzie river in the North-west Territories.
10 Burrard inlet, British Columbia, including also the city of Vancouver.

Commencing at the most easterly limits of the beds on the International Boundary Line there is a small area at Turtle mountain, Manitoba, constituting the northern portion of a formation which extends southward into North Dakota. It extends along the Boundary Line for a distance of about thirty-four miles, while its extension northward amounts to about twenty-five miles. Farther west, at 102 degrees of west longitude, another outcrop appears in a northerly extension of the corresponding beds in North Dakota and Montana. This area extends along the Boundary Line to Wood mountain, a distance of 212 miles, where the margin becomes frayed out into irregular and often detached portions due to contact with the hill country. On its eastern boundary the formation runs northwesterly for 250 miles to a point near the 107th degree of west longitude, where the greatest northern extension takes the form of a narrow arm which projects from the main area for seventy-five miles. The western limits trend to the eastward, and bend around the east side of Lakes Chaplin and Johnston, but after passing them again trend to the west and south until the neighbourhood of Wood mountain is reached. At latitude 51 degrees, in the great bend of the Saskatchewan river, there is an outlier of fair size; while from latitude 50 south to the Boundary Line and west to about the 110th degree of west longitude, there are several outliers of varying sizes. These areas include the first four of the localities enumerated.

The principal lignite area crosses the International Boundary Line at the 113th Meridian, on each side of which it is about equally distributed for a total extent of about twenty-five miles. Thence it extends northward with but slightly increasing width until, at the crossing of the Canadian Pacific railway in the neighbourhood of Oldman river, it begins to expand somewhat rapidly and thus continues until at the latitude of Beaver lake it attains its maximum width of 225 miles. The northern limits are reached at Lesser Slave lake, along the southern side of which it has an almost easterly and westerly extension of 175 miles. It will thus be seen that the area has the form of a great lake extending north and south for 450 miles, within an otherwise Cretaceous area, upon the strata of which the Eocene beds were deposited conformably. Within this area are found the localities Cochrane, Calgary, Red Deer river and Edmonton. No other Eocene area is to be met with east of the Rocky mountains until the far northern region of Fort Norman is reached. There is found a small outlier about 25 by 37 miles in extent. As the Bear river flows southward into the Mackenzie river it cuts through the Tertiary deposits for about six miles, and it was from the exposures thus made that Sir John Richardson obtained his collections afterwards determined by Heer and Schroeter, although other specimens have also been obtained from the cutting of the Mackenzie river which traverses the area for about twenty miles. It will thus be observed that collections from the Mackenzie river are of the same horizon as those from the Bear river.

In British Columbia there are several areas of Lignite Tertiary age, though none of these are large, and they are all somewhat widely separated. These are, according to present information :—

1. Burrard inlet and Vancouver.
2. Omineca river.
3. Finlay river.
4. Coal brook.
5. Blackwater river.

At Vancouver there is a very limited exposure from which Sir William Dawson described a number of plants in 1895.[1] But on the opposite side of Burrard inlet there is an area which extends southward to the Boundary Line, and along it for a distance of about fifty-four miles. This is the locality known as Burrard inlet, and from it Sir William Dawson described a large number of plants, several of them new (*Op. cit.*).

In 1885 (*Op. cit.*), Sir William Dawson was able to correlate the Burrard Inlet and Vancouver floras with that from the Tertiary areas east of the Rocky mountains, as well as with corresponding horizons in the United States. He had previously shown, however, in a very convincing manner, that the entire southern area east of the mountains was of lower Eocene age, equivalent to the Fort Union group of Montana and Dakota; that the beds are composed of clays and sandstones resting conformably upon Cretaceous beds of the Fort Pierre and Fox Hills groups, and holding remains of plants together with lignites and shells. This correlation with the Upper Laramie as established by Sir William Dawson and other Canadian Geologists has long been recognized and accepted, and subsequent evidence has not in any way served to render it otherwise than stable.

The outlying area of the Mackenzie river was first held by Heer to be of Miocene age, and the error which led to this conclusion also led him to assign to the same age the Tertiary beds of Saghalien, Spitzbergen and Greenland, a misconception which he persisted in adopting as late as 1880.[2] But, as shown by Sir William Dawson on several occasions, and emphasized in 1882,[3] there can be no doubt whatever that all the localities thus referred to are of Laramie age. This view was not adopted by American palaeobotanists as late as 1898, since in his Catalogue of Cretaceous and Tertiary Plants published in that year by Dr. F. H. Knowlton[4] of the United States Geological Survey, he not only assigns the Mackenzie river, Porcupine creek and Souris river to the Miocene, but in an account of the Fossil Flora of Alaska, published in 1904,[5] he refers to the Atane beds of Greenland as belonging to the same horizon. In a later publication, however,[6] these views are materially modified, since we there find the "Arctic Miocene" referred to as Upper Eocene, while the Mackenzie River beds are referred to the Fort Union group. Much confusion still exists as to the stratigraphical position of many Tertiary plants, and it will no doubt be some time before a satisfactory knowledge of their distribution is reached.

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[1]Trans. R. S. C., N. S. I, 1895, iv, 137-161.
[2]Proc. R. Soc. Lond., 18.
[3]Trans. R. S. C., I, 1882-83, iv, 29-30; N. S., I, 1895, iv, 150.
[4]U. S. Geol. Surv, Bull. 152, 1898.
[5]Foss. Flor. Alaska. Proc. U. S. Nat. Mus., XVII, 1894, 207-240.
[6]Foss. Plants from Kukak bay. Harriman Xxp., IV, 1904, 162.

MIOCENE.

The great majority of the supposedly Miocene localities of British Columbia have been studied exhaustively by Sir William Dawson. Most of these have been restudied through the medium of more recent collections, and some additions to the flora have been made. In addition, several localities previously but little known, and others wholly new, have been studied through the collections made by Dr. R. A. Daly in 1903-1905, and by Lambe in 1906. As all of these fall within the British Columbia area, and therefore within limits supposed to be largely Miocene, they may be joined in one provisional list for detailed consideration. The localities are as follows :—

A. Similkameen Area,

1. Kettle river.
2. Similkameen river in general.
3. Nine-mile creek.
4. Whipsaw creek.
5. Tulameen river (North Similkameen).

B. Quesnel Area

6. Coal gully.
7. Quilchena.
8. Quesnel.
9. Coldwater river.
10. Stump lake.
11. Horsefly river.
12. Cariboo.
13. Blackwater river.

C. Kamloops Area

14. Kamloops.
15. Tranquille river.

D. Peace River Area.

16. Finlay river.
17. Omineca river.

E. Indian River.

18. Coal brook.

The entire Tertiary area of British Columbia is made up of a series of lakes, many of them small, and often widely separated from the main formation which is very irregular in outline. These areas lie within a region approximately 150 miles wide, and at least 1,250 miles long, commencing at the International Boundary.

The localities most recently studied, and about which there was the most uncertain knowledge, will receive consideration first. They are :—

1. Coal brook.
2. Omineca river.
3. Finlay river.
4. Blackwater river.
5. Kamloops
6. Tranquille river.

COAL BROOK.

As already shown, Coal brook lies within the Indian reserve on the North Thompson river, and belongs to a very small area of Tertiary formation constituting an outlier widely separated from the main group of deposits, and according to the opinion of Sir William Dawson, already quoted, the formation may be of somewhat more recent age than the Laramie of the plains.

The very scanty flora so far collected, embraces the following representatives :—

1. *Populus arctica.*
2. *genetrix.*
3. *subrotunda.*
4. *Pyrus* sp.
5. *Rhus rosæfolia ?*
6. *Thuya interrupta.*
7. *Ulmus* sp.

Of these seven forms we may at once eliminate *Ulmus* sp and *Pyrus* sp. as of no value, and the same may also be said of *Rhus rosæfolia,* since the specific form in this case is inferred rather than proved. We, therefore, have only four constituents of the flora upon which to place reliance.

Populus arctica is a species well known to both the Eocene and Miocene of the United States and Canada, and Knowlton[1] states that it is abundant from the Laramie to the Miocene, or throughout the Tertiary. It is obvious that such a general type can have but little value as a factor in determining age.

Populus genetrix has been found at Red Deer river and also at Quilchena, but in the United States it is wholly confined to the Fort Union group, and its aspect is, therefore, decidedly Eocene or Lignite Tertiary.

Populus subrotunda in Canada is altogether confined to Coal brook, while in the United States it is wholly confined to the Laramie of Carbon and Evanston, Wyoming, and localities of equivalent horizon.

Thuya interrupta is known at Porcupine creek, but it also occurs in the Miocene? of Nine-mile creek and at Quilchena. In the United States, on the other hand, it is wholly confined to the Fort Union group.

From the facts thus brought forward it appears that all three species are well known constituents of the Lignite Tertiary. But as *Populus genetrix* belongs to the beds in question

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[1] Cat. Cret. and Tert. Plants, U.S. Geol. Surv., Bull. 152, 1898.

it cannot be utilized as an age factor, and the only other species elsewhere represented is *Thuya interrupta* which belongs to the lower Miocene or Oligocene. It is clear, then, that so far as the present information will warrant such conclusions, Coal brook must be regarded as certainly Eocene, and probably Lignite Tertiary or Laramie, thus confirming in the main the conclusions reached by Sir William Dawson.

OMINECA RIVER.

The flora of the Omineca river embraces the following :—

1.	*Arundo* sp.	Eliminated.
2.	*Leguminosites arachioides.*	Cret. Eocene, Miocene ?
3.	*Platanus haydenii.*	Lignite Tertiary.
4.	*Populus arctica.*	General distribution.
5.	*nebrascencis.*	Lig. Ter., L. Miocene.
6.	*speciosa.*	Lignite Tertiary.
7.	*Quercus* sp.	Eliminated.
8.	*Sequoia couttsiæ.*	Cret., Lig. Ter., L. Miocene.
9.	*langsdorfii.*	Cret., Lig. Ter., L. Miocene.
10.	*Viburnum asperum.*	Lignite Tertiary.

Both *Arundo* and *Quercus* may be eliminated from the list without further consideration, and *Populus arctica*, being common to the entire Tertiary, may also be left out of account.

Leguminosites arachioides was first observed by Sir William Dawson in the beds of the Similkameen river, and to that extent it may be regarded as of Lower Miocene? age. Lesquereux, however, who first described these peculiar fruits and assigned them with a question to the genus *Leguminosites*, obtained his material from the Fort Union beds of Montana, as well as from the Denver group of Middle park, Colorado, and the Laramie of Evanston, Wyoming. If then we leave out of account the Horsefly river, which we may provisionally regard as Miocene in accordance with previous determinations, this species must be regarded as decidedly Eocene, with a strong Laramie aspect.

In Canada, *Platanus haydenii* has otherwise been found only in the Lignite Tertiary of Porcupine creek and related localities. Within the limits of the United States it is also wholly confined to the Lignite Tertiary. From this evidence we must regard it as a pronounced Laramie type.

Populus arctica has already been shown to be without special, stratigraphical value, but if we were to add such evidence as it affords it would be seen that it occurs in five localities in Canada, known to be Laramie, but to only one locality supposedly Miocene; therefore it would show a tendency toward an Eocene, rather than a Miocene horizon.

Populus nebrascencis is known to only one other locality—Quilchena—which has been regarded as Miocene. In the United States it is known exclusively to the Fort Union and Denver groups, from which its Laramie character becomes obvious.

Populus speciosa is found nowhere else in Canada, but Ward's original specimen was obtained from the Fort Union group of Montana, which leaves no doubt as to its place in the flora of the Lignite Tertiary.

Sequoia couttsiæ has been found in two other localities in Canada, Red Deer river and Finlay river, the former Lignite Tertiary and the latter of undetermined horizon. This species also occurs in the Cretaceous of Staten island, but it is not otherwise recorded in the United States. Heer, however, has noted its occurrence in the Eocene of Greenland. We cannot doubt, therefore, that this must be regarded as a type of the Lignite Tertiary.

Sequoia langsdorfii is known to occur in two localities of well-defined Laramie age, but it is also found in two localities of Miocene age, three of supposedly Miocene and one of doubtful relations. It must be noted, nevertheless, that it is an element of the Cretaceous flora at Nanaimo, while it also occurs in the Eocene of Green river and the Fort Union group of Montana. It has also been found in the United States, in the Upper Clarno beds of the John Day basin, Oregon, a formation which Knowlton has determined to be Upper Eocene.

Heer has observed this species in the Lower Eocene of Alaska, Greenland, Spitzbergen and Saghalien, from all of which it may be concluded that it is an Eocene species more typical of the lower than the upper.

Viburnum asperum is known in Canada, to the Porcupine Creek group, Red Deer river and Finlay river, the last of which must be neglected as of uncertain age. Upon turning to its distribution in the United States, it is found to be known in the Fort Union group of Montana, only, and from the evidence thus obtained it must be concluded that this is a species, characteristic chiefly ot the Lower Eocene, with affinities towards the Cretaceous on the one hand, and with the Upper Eocene on the other.

This analysis shows

Cret., Lig. Ter., L. Miocene	4
Lignite Tertiary	3
Lig. Ter., L. Miocene	1

and from such evidence it must be concluded that the formation at the Omineca river is of Lignite Tertiary age.

FINLAY RIVER.

The Finlay River beds occupy a somewhat isolated position near the Omineca River beds and the two have been assumed to be the same. Only five representatives of its flora have as yet been studied.

1. *Grewia* sp.	Eliminated.
2. *Leguminosites arachioides.*	Cret., Eocene, Miocene?
3. *Sequoia couttsiæ.*	Cret., Lig. Ter., L. Miocene.
4. *langsdorfii.*	Cret., Lig. Ter., L. Miocene.
5. *Viburnum asperum.*	Lignite Tertiary.

An inspection of this very scanty flora shows, nevertheless, that it is identical with that of the Omineca river, and that the horizons indicated are the same, from which the inference is derived that it is of the same age or Lignite Tertiary.

BLACKWATER RIVER.

The little known flora of the Blackwater river embraces only six species as follows:—

1. *Castanea castaneæfolia.*	Oligocene? U. E., to L. M.
2. *Diospyros alaskana.*	Cret., Lig. Ter., U. Miocene.
3 *Fagus feroniæ.*	Oligocene? Lig. Ter., M., Pliocene.
4. *Sequoia langsdorfii.*	Cret., Lig. Ter., L. Miocene.
5. *Taxodium occidentale.*	Lig. Ter., Oligo., L. Miocene.
6. *Thuya interrupta.*	Lig. Ter. and Oligocene.

Castanea castaneæfolia occurs in only three other localities, the Horsefly river, Quesnel and Kamloops, of which the first and second are Upper Eocene and the last is Lower Miocene.

In his catalogue for 1898 Knowlton records this species as found in the Miocene of the John Day basin, Oregon ; but in a revision of this flora at a later date (1902), he notes more specifically that it occurs in the Lower Clarno beds of Cherry creek, which he regards as of Lower Eocene age. It therefore has a definitely Laramie aspect which is only partially offset by its occurrence in the Upper Eocene and Lower Miocene as stated, but is probably sufficient to place it in the Oligocene or Upper Eocene age.

Diospyros alaskana is found in Canada, only at the Blackwater river, and we must therefore look elsewhere for its proper stratigraphical position. In the United States it is an Eocene type, chiefly of Laramie age, though it does not appear to have been found in the Fort Union group. It has, however, been recorded from the Lower Clarno beds of Cherry creek, Oregon, regarded as Lower Eocene. It may be pointed out that, with the exception of *Diospyros elliptica*, Kn., recorded by Knowlton from the Mascall beds of Van Horne's ranch, and regarded as Upper Miocene, and *D. virginiana turneri*, the genus as a whole, as represented by nineteen out of twenty-one species, is distinctly older than the Miocene, ranging from the Dakota group to the Lignite Tertiary. This relation also holds true of its occurrence in Greenland and Saghalien as shown by Heer. The genus is clearly and strongly Lower Eocene, and the evidence also favours the application of the same view to the species.

Fagus feroniæ is at present known to only two localities—the Blackwater river and Quesnel, the latter being Upper Eocene. In the United States this species is known to the Green River station at Elko, Nevada. In Alaska it occurs in the Eocene of Port Graham, and the same horizon holds for Saghalien. In Europe, on the other hand, it ranges from the Oligocene to the Pliocene, being about equally devided between the Lower Eocene and the Upper Miocene. The general tendency of the evidence afforded by this plant would seem to be toward an Oligocene age.

Sequoia langsdorfii, dealt with elsewhere, has already been shown to afford evidence of a Lower Eocene age, and the same may also be held as true of *Thuya interrupta*.

Taxodium occidentale occurs in a large number of localities, both Eocene and Miocene, throughout western Canada. It is a well defined constituent of the Porcupine Creek and Great Valley groups, and of the Mackenzie river, both of them of undoubted Lignite Tertiary age. This appears in perfect accord with the distribution of the species in the United States, within the limits of the Fort Union group only. It does not appear to have been found in the more recent collections from Alaska. It is found in the Similkameen river, the Horsefly river and at Quilchena, all of Upper Eocene or Oligocene age. It is also known to the flora of the Tranquille river which is Lower Miocene or Oligocene.

It is therefore clear that the general evidence points with force to the Eocene character of *Taxodium occidentale*.

The conclusion to be reached with respect to the age of the Blackwater beds is that they are probably of Lower Eocene, but approaching very closely to the Upper Eocene as represented by the Quesnel beds.

KAMLOOPS.

The very limited flora from the Kamloops beds was first studied by Sir William Dawson, and his results constitute the bulk of available evidence at the present moment. The recognized forms are :—

1	*Carpolithes* sp.	Excluded.
2	*Castanea castaneæfolia.*	Oligocene, U. E. — L. M.
3	*Comptonia diforme.*	Oligocene, L. M.
4	*Salix kamloopsiana.*	

From this we at once exclude *Carpolithes*, while *Salix kamloopsiana* is of no present value since it has been found at no other station. The two species remaining afford a very inadequate basis for conclusions, and these can only be presented tentatively.

Castanea has already been found to be of Oligocene age. *Comptonia diforme* is found in only one other locality in Canada, which, according to accepted views, is to be regarded as Lower Miocene. According to the latest revision of the genus by Berry[1] this species is wholly Tertiary, extending from the Eocene to the Miocene. It may be further remarked that *C. diforme* is not comparable with *C. matheronianum* as Dawson supposed, but rather, as Berry points out, with *C. partita*, Lesq. from the Green River beds which are to be regarded as Oligocene or Upper Eocene.

The conclusion to be derived from this limited and very unsatisfactory evidence would be that the Kamloops beds probably belong to the Oligocene, certainly not higher, possibly lower.

QUESNEL.

The somewhat limited flora of Quesnel embraces nineteen genera and species :—

1	*Acer* sp.	
2	*grossedentatum*	Miocene of Europe.
3	*Betula prisca ?*	Laramie.
4	*Carya* sp.	
5	*Castanea castaneæfolia*	Oligocene, U. E. — L.M.
6	*Pterospermites* sp.	
7	*Quercus* sp.	
8	*pseudocastanea.*	Lignite Tertiary.
9	*Rhamnus* sp.	
10	*Nordenskioldia borealis.*	Cret. and Lig. Ter.
11	*Nyssidium* sp.	
12	*Platanus* sp.	
13	*aceroides.*	Eocene to U. Mioc. chiefly Laramie.
14	*Populus arctica.*	General distribution.

1 Amer. Nat., XL, 1906, 518.

15	*Dombeyopsis islandica.*	Laramie.
16	*Fagus antipofi.*	Lar. — M. Oligocene. Chiefly Eocene.
17	*feroniæ.*	Lig. Ter., M., Plio. Oligocene.
18	*Hypnum columbianum.*	Only locality.
19	*Taxodium distichum miocenum,*	General distribution.

From this we may at once eliminate all generic forms and the two species of general distribution. We may also exclude *Hypnum* because of its doubful character. *Castanea castaneæfolia* and *Fagus feroniæ* have already been found to be of Oligocene age. There therefore remain only seven well recognized species which can aid in establishing the stratigraphical relations.

Betula prisca? is unknown to any other locality in Canada, but in the United States it is a characteristic feature of the flora of Fort Union, Montana, which is the only locality so far known. In Alaska it is found in the Eocene of Port Graham, and it also occurs in the lower Eocene of Spitzbergen and Saghalien. From this evidence it must be regarded as a well defined Laramie species.

Acer grossedentatum is unique in its occurrence at Quesnel. It is, however, known to the Miocene of Europe as described by Heer.

Quercus pseudocastanea is unknown in the United States, but it occurs in the Eocene of Port Graham, Alaska, in the Atane beds of Greenland and Saghalien.

Nordenskioldia borealis has been recorded from the Mackenzie river in Canada. Its occurrence in the Dakota group of the United States gives it a decidedly Cretaceous aspect which is not diminished by its presence in any other horizon.

Platanus aceroides, also from the Tertiary of the Mackenzie river, is found in the United States as a common element of the Fort Union group; but in one instance Knowlton records it, with hesitation, from Van Horne's ranch in the John Day basin, Oregon, a formation which he regards as Upper Miocene.

Dombeyopsis islandica is not known to the Tertiary of the United States, but it should be noted that the genus as represented there, by four species, is characterized by being exclusively Laramie.

Fagus antipofi occurs in the Eocene of Port Graham, Alaska, and the Laramie of Wyoming; but according to Knowlton it is also found in the Miocene of California. It is, however, known to the Lignite Tertiary of Greenland and Saghalien.

A review of these facts shows the following distribution :—

Cretaceous and Lignite Tertiary - - - - - -	1
Laramie or Lignite Tertiary - - - - - - - - - -	3
Eocene to Miocene, chiefly Laramie - - - - - - -	1
Laramie to Miocene, chiefly Eocene - - - - - - - - -	1
Upper Eocene to Lower Miocene (Oligocene) - - - - - -	1
Laramie to Pliocene (Oligocene) - - - - - - - -	1
General distribution - - - - - - - - -	2

From this analysis it is clear that the beds at Quesnel must be regarded as of Eocene age, with a strong tendency to Laramie.

COAL GULLY.

Coal gully presents at this time a somewhat limited flora based partly upon determinations by Sir William Dawson, but more particularly upon collections made by Lambe in 1906. It is as follows :—

1, *Ficus* sp.	
2. *Phragmites* sp.	
3. *Populus acerifolia.*	General distribution
4. *polymorpha.*	Upper Eocene.
5. *Sequoia langsdorfii.*	Cret., Lig. Ter., L. Miocene.
6. *Taxodium distichum miocenum.*	General distribution.
7. *Typha latissima.*	Lar., U. Eoc., Oligo., L. Miocene.
8. *Ulmus speciosa.*	U. Eoc.
9. *Vitis rotundifolia.*	Lig. Ter ?

Excluding from this list generic forms and species of general distribution, there remain only five species upon which an opinion may be formed. Of these one, *Vitis rotundifolia*, may be eliminated on account of the uncertainty of its present horizon. Of the remaining four, two are Upper Eocene, one is found from the Cretaceous to the Lower Miocene, and one ranges from Laramie to Lower Miocene. The evidence therefore shows that the beds of Coal gully are probably of Upper Eocene or Oligocene age, but in view of the very unsatisfactory material, this conclusion is adopted only provisionally.

QUILCHENA.

The close proximity of Quesnel and Quilchena would suggest that the two may be of the same age. The Quilchena flora is one of the largest from any single locality in British Columbia, embracing 62 genera and species.

DISTRIBUTION OF THE QUILCHENA FLORA.

——	Eliminated Genera.	General Distribution.	Exclusively Quilchena.	Eocene Lig. Ter.	Miocene.	Oligocene.
Alnites curta					×	× U. E.
Alnus sp.	×					
serrulata fossilis						× U. E.
Amygdalus gracilis						× U. E.
Aralia acerifolia				×	×	
notata				×	×	× U. E.
Betula angustifolia						× U. E.
heterodonta						× U. E.
Carex sp.	×					
Carpinus grandis				×	× M.	× U. E., L. M.
Carpolithes sp.	×					
dentatus					×	× L. M.
Carya antiquorum				×	×	× U. E.

DISTRIBUTION OF THE QUILCHENA FLORA—*Continued.*

——	Eliminated Genera.	General Distribution.	Exclusively Quilchena.	Eocene Lig. Ter.	Miocene.	Oligocene.
Castanea intermedia						× U. E.
Comptonia dryandroides				×	×	
quilchenensis			×			
Cornus newberryi				× E.		
suborbifera				×		
Corylus americana				×	×	× U. E
Cyperites sp.	×					
Dryophyllum stanleyanum				×		
Ficus decandolleana						
ungeri						× U. E.
Gingko adiantoides				×	×	× U. E., L. M.
digitata				×		
Glyptostrobus europœus		×				
Grass seeds	×					
Juglans nigella				×		
Picea quilchenensis			×			
Pinus sp.	×					
lardyana					×	
steenstrupiana					×	
trunculus					×	× U. E.
Populus sp.	×					
accrifolia		×				
cordata				×	×	
genetrix				×		
mutabilis oblonga					×	
nebrascencis				×		
obtrita				× ?	×	
Prunus merriami					×	
Quercus castaneopsis				×		
consimilis						× U. E.
Rhamnus sp.	×					
elegans			×	×		× U. E.
gaudini						
quilchenensis			×			
Salix orbicularis			×			
perplexa					×	
varians				×		× U. E., L. M.

DISTRIBUTION OF THE QUILCHENA FLORA—*Concluded.*

——	Eliminated Genera.	General Distribution.	Exclusively Quilchena.	Lig. Ter. Eocene	Miocene.	Oligocene.
Sassafras sp.	×					
Sequoia sp.	×					
angustifolia				×	×	× U. E.
heerii					×	× U. E.
nordenskioldii				×	×	× U. E.
Taxodium distichum miocenum		×				
occidentale				×	×	× U. E., L. M.
Taxites olriki				×	×	
Thuya interrupta				×	×	
Ulmus speciosa						× U. E.
Vitis rotundifolia				× E.		
Zanthoxylum spireæfolium						× U. E.
Total.........62	10	3	4	22	23	

This table shows the following proportional distribution :—

Eliminated genera	10
Species of general distribution	3
Exclusively Quilchena	4
Lignite Tertiary	21
Miocene Tertiary	22
Oligocene (Green river)	12
Eocene	1

An analysis of this table makes it clear that the species are about equally distributed between the Eocene and the Miocene, while somewhat more than half as many occur in the Oligocene or Upper Eocene. To deal with specific cases, *Carpinus grandis*, although found in the Eocene, is essentially a Miocene type. *Prunus merriami* and *Salix perplexa* are known only to the Miocene. *Ulmus speciosa* is an Oligocene type characteristic of the Green River group. *Alnus serrulata fossilis* is a recognized constituent of the Upper Eocene at Bridge creek, Oregon. *Pinus lardyana* and *P. steenstrupiana*, found for the first time on this continent, are distinctively Miocene types, which is also true of *Populus mutabilis oblonga*, all three being European species. *Ficus decandolleana* is likewise from the European Miocene.

On the other hand, *Cornus suborbifera*, *Corylus americana*, *Dryophyllum stanleyanum*, *Juglans nigella*, *Populus genetrix*, *Quercus castaneopsis*, *Rhamnus elegans* and *Salix varians* are essentially Eocene types, and chiefly of Laramie age. With respect to *Dryophyllum*, it may be observed that the four species known to the United States are all of Eocene age, whence it may be inferred that the genus is characteristic of that formation.

The conclusion which these facts indicate is that the beds of Quilchena are Upper Eocene or Oligocene, and that they cannot be more recent unless there has been a mingling of Eocene and Miocene types. This is indeed suggested by the intermingling of such strong Eocene types as *Dryophyllum stanleyanum*, *Juglans nigella*, *Populus genetrix*, *P. nebrascencis*, *Quercus castaneopsis* and *Rhamnus elegans* with Miocene types such as *Pinus trunculus*, *Populus obtrita*, *Salix perplexa*, *Prunus merriami*, *Sequoia angustifolia* and *S. heerii*.

TRANQUILLE RIVER.

It has generally been supposed that the Kamloops beds and those at the mouth of the Tranquille river, which empties into Kamloops lake from the north, belong to one formation. But out of the plants from Kamloops there is only one representative (*Carpolithes* sp.) which is also found in the Tranquille river. In point of representative plants common to the two there is therefore no obvious connexion between the two floras, and that of the Tranquille river must be examined in detail. It embraces in all 37 species and genera.

DISTRIBUTION OF THE TRANQUILLE RIVER FLORA.

——	Eliminated Genera.	General Distribution.	Exclusively Tranquille River.	Eocene Lig. Ter.	Miocene.	Oligocene.
Alnus carpinoides						× U. E.
Andromeda delicatula						× U. E.
Betula sp.	×					
heterodonta						× U. E.
macrophylla				×		
Carpinus grandis				×	× Ch.	× U. E., L. M.
Carpolithes sp.	×					
dentatus					×	× L. M.
Carya antiquorum				×	×	× U. E.
Cinnamomum affine				×		
Corylus americana				×		× U. E.
Cratægus tranquillensis						× U. E., L. M.
Cyperites sp.	×					
Ficus asiminæfolia					×	
Gingko adiantoides				×	×	
Glyptostrobus europæus		×				
Juglans rhamnoides				×		
Picea tranquillensis			×			
Pinus sp.	×					
trunculus					×	
Planera longifolia					×	× U. E.
Populus acerifolia		×				

DISTRIBUTION OF THE TRANQUILLE RIVER FLORA—*Concluded.*

——	Eliminated Genera.	General Distribution.	Exclusively Tranquille River.	Eocene Lig. Ter.	Miocene.	Oligocene.
Populus cuneata				×	×	
mutabilis oblonga						× U. E.
zaddachi				×	×	
Rhamnus eridani				×		
Salix varians				×		× U. E., L. M.
Sequoia sp.	×					
angustifolia					×	× U. E.
brevifolia					×	
heerii					×	× U. E.
langsdorfii				×	×	
Taxodium distichum miocenum		×				
occidentale				×	×	
Typha latissima					×	× U. E.
Ulmus tenuinervis						× U. E.
Viburnum dentoni				×		
Total=37	5	3	1	14	15	15 14 U.E 4 L. M

An inspection of the distribution shown in the above table conveys the information that there are

Eocene, chiefly Lignite Tertiary	14
Oligocene,—	
Upper Eocene	14
Lower Miocene	4
Miocene	15

thus giving a preponderance of the Eocene over the Miocene, in the proportion of 28 to 19; but inasmuch as the Eocene and the Miocene are practically equal, while there are 18 Oligocene, the conclusion appears justified, to the effect that these beds are of Oligocene age, and possibly not higher than Upper Eocene, though the presence of such strong Miocene types as *Ficus asiminæfolia*, *Pinus trunculus* and *Sequoia brevifolia* would seem to give them a stronger Miocene tendency. I therefore assign them to the Lower Miocene provisionally.

STUMP LAKE.

Stump lake is one of the localities about which very little information has as yet been obtained. The known flora contains only eight genera and species.

DISTRIBUTION OF THE STUMP LAKE FLORA.

——	Eliminated Genera.	General Distribution.	Exclusively Stump Lake.	Eocene Lig. Ter.	Miocene.	Oligocene.
Acer sp.	×					
Acerites negundifolium			×			
Azollophyllum primævum	×					
Carpinus grandis				×	×	×
Carpolithes dentatus					×	×
Glyptostrobus europæus		×				
Pinus trunculus					×	×
Taxodium distichum miocenum		×				
Total=8	2	2	1	1	3	3

The obvious conclusion to be derived from the distribution here shown is to the effect that the beds are of Lower Miocene or Oligocene age.

HORSEFLY RIVER.

The flora of the Horsefly river has been worked out particularly through the recent collections of Lambe in 1906. As now known it embraces fifty-one representatives, and, as one of the largest from any single locality, it affords a clear idea of the character of the vegetation and its relation to other Tertiary floras.

DISTRIBUTION OF THE FLORA OF THE HORSEFLY RIVER.

——	Eliminated Genera.	General Distribution.	Wholly Horsefly.	Miocene.	Eocene or Lig. Ter.	Oligocene.
Acer sp.	×					
dubium			×			
trilobatum productum					×	
Alnites curta				×		× U. E.
Alnus carpinoides					×	× U. E. L. M.
Aralia notata				×	×	× U. E.
Carex sp.	×					
Carpolithes sp.	×					
dentatus					×	× U. E., L. M.
Carya antiquorum				×	×	×
Castanea castaneæfolia			×	×	×	× L. M.
Cinnamomum affine					×	× L. M.
Corylus americana				×	×	× U. E., L. M.
macquarrii					×	
Cratægus tranquillensis						× L. M.
Cupressoxylon dawsoni					×	

DISTRIBUTION OF THE FLORA OF THE HORSEFLY RIVER—*Concluded.*

——	Eliminated Genera.	General Distribution.	Wholly Horsefly.	Miocene.	Eocene or Lig. Ter.	Oligocene.
Cyperites sp.	×					
Ficus sp.	×					
asarifolia					×	
populina				×		
Gingko adiantoides				×	×	× U. E., L. M.
Glyptostrobus europæus		×				
Grewia crenata					×	
Juglans occidentalis					×	×
Leguminosites arachioides				×	×	
Myrica sp.	×					
personata						× U. E.
Nelumbium pygmæum				×		
Onoclea sensibilis					×	
Pinus sp.	×					
trunculus				×		× U. E., L. M.
Planera longifolia				×		× L. M.
crenata					×	
Populus sp.	×					
acerifolia		×				
latior				×	×	
Pseudotsuga miocena					×	
Quercus sp.	×					
Rhamnus elegans					×	× U. E.
quilchenensis						× U. E.
Salix varians					×	× U. E., L. M.
Sequoia sp.	×					
angustifolia				×	×	× U. E., L. M.
heerii				×		× U. E., L. M.
nordenskioldii					×	× U. E.
Taxodium distichum miocenum		×				
laramianum					×	
occidentale				×	×	× U. E., L. M.
Typha latissima				×	×	× U. E., L. M.
Ulmus minuta				×		
speciosa						× U. E.
Total, 51	10	3	2	17	26	23 17 = U. E. 13 = L. M.

From the analysis of the flora thus presented it appears that out of 51 specimens fifteen may be excluded for various reasons. The remaining 36 then show the following general distribution.

Eocene, chiefly Lignite Tertiary	26
Upper Eocene or Oligocene	17
Lower Miocene or Oligocene	13
Wholly Miocene	17

It further appears that those which favour an altogether Eocene age are 43, while those favouring a Miocene age are 30, and those which are Oligocene within the limits of those two groups, number 30.

Of those which are wholly Eocene we may note *Acer trilobatum productum*, *Corylus macquarrii*, *Cupressoxylon dawsoni*, *Ficus asarifolia ? Grewia crenata*, the equally strong type *Onoclea sensibilis*, *Planera crenata*, *and Taxodium laramianum*, eight species in all. On the other hand, of those which are wholly Miocene, there are *Nelumbium pygmæum* and *Ficus populina*, only two. The evidence is very strong, therefore, as showing that the beds of the Horsefly are in reality Oligocene, with a much stronger affinity with the Eocene than with the Miocene.

KETTLE RIVER.

The Kettle River flora is a limited one, embracing only 14 species, with the following distribution :—

DISTRIBUTION OF THE KETTLE RIVER FLORA.

——	Eliminated Genera.	General Distribution.	Wholly Kettle River.	Eocene Lig. Ter.	Miocene.	Oligocene.
Betula sp.	×					
Potamogeton sp.	×					
Cupressoxylon macrocarpoides. Cret.			×			
Cyperites sp.	×					
haydenii						× U. E.
Fern stipes	×					
Phragmites sp.	×					
Picea columbiensis.			×			
Pinus columbiana			×			
Taxodium distichum miocenum		×				
Ulmus sp.	×					
columbiensis			×			
proto-americana			×			
proto-racemosa			×			
Total=14	6	1	6	0	0	1

This analysis shows very clearly that the flora of Kettle river is composed of elements which are practically unknown elsewhere, with the exception of *Cupressoxylon macrocarpoides* and *Cyperites haydenii.* It is therefore evident that these two are the only species upon which to base conclusions, a procedure which would be unsafe without further corroborative evidence. With respect to *Cupressoxylon*, it has been shown that the only locality hitherto known is to be found in the Cretaceous of the South Saskatchewan river, near Medicine Hat. This would have a tendency to show that the formation in question must be early Eocene, probably of Fort Union age. *Cyperites haydenii* has been found in no other Canadian locality, but it has been recognized by Lesquereux in the Green River group of Wyoming. It is a species of somewhat rare occurrence, and its testimony affords only limited evidence of the age of the formation in which it is now found. So far as this may be relied upon, however, it indicates very definitely an Upper Eocene or Oligocene age.

With respect to the other five species upon which conclusions might be based, were they found elsewhere, all that can be said of them is that their general facies appear to be later than the Fort Union group, but whether Upper Eocene or Lower Miocene it is impossible to say. On the basis of the evidence available it would probably be safe to assign the Kettle River beds, provisionally, to the Upper Eocene or Oligocene.

NINE-MILE CREEK.

Another flora of very limited extent is that from Nine-mile creek on the Similkameen river, and from the geographical relations of the two this has been assumed to be of the same age as that of Whipsaw creek. But a separate analysis is desirable. Only 13 forms are known.

DISTRIBUTION OF THE FLORA OF NINE-MILE CREEK.

——	Eliminated Genera.	General Distribution.	Wholly Nine-mile Creek.	Eocene Lig. Ter.	Miocene.	Oligocene.
Corylus sp.	×					
Equisetum similkameenense.			×			
Glyptostrobus europæus		×				
Juglans sp.	×					
Myrica sp.	×					
Nelumbium sp.	×					
Platanus sp.	×					
Populus arctica				× Cbf.		× U. E.
latior cordifolia				×		× U. E.
Sapindus sp.	×					
Sequoia brevifolia				×		× L. M.
langsdorfii				×		× U. E., L. M.
Thuya interrupta				×		× U. E.
Total=13	6	1	1	5	0	5

Only five of the species enumerated above are of value for stratigraphical purposes. Of these none are found in the Miocene wholly, while there is an even distribution between the Lower Eocene or Laramie and the Oligocene. If these latter be analysed more particularly, it will be observed that there are three cases belonging to the Upper Eocene exclusively, one to the Lower Miocene and one which is common to both. It therefore seems probable, in view of this very strong tendency toward the Eocene, that the horizon is that of the Lower Oligocene or Upper Eocene, and not higher.

SIMILKAMEEN RIVER.

The flora designated as Similkameen river is not from any one locality, but it represents specimens taken from localities not otherwise designated, though within the Similkameen valley. As here given it embraces 24 forms, and presumably includes localities such as Similkameen, Tulameen, etc., etc., as well as the main stream itself. It should, therefore, show a correspondence with the Similkameen flora as a whole.

DISTRIBUTION OF THE SIMILKAMEEN RIVER FLORA.

——	Excluded Genera.	General Distribution.	Wholly Similkameen River.	Eocene Lig. Ter.	Miocene.	Oligocene.
Antholithes sp.	×					
Betula	×					
stevensoni				×		
Carpinus grandis				×	× Ch.	× U. E,, L. M.
Carya antiquorum				×	×	× U. E., L. M.
Comptonia dryandroides					×	× U. E., L. M.
Cyperites sp.	×					
Ficus sp.	×					
Leguminosites arachioides				×		× U. E.
Magnolia sp.	×					
Nelumbium sp.	×					
pygmæum						× U. E.
Osmunda heerii					×	
Phragmites sp.	×					
Pinus trunculus						× U. E., L. M.
Populus daphnogenoides				×		
obtrita				×		× U. E.
rotundifolia				×		
zaddachi				×	×	× U. E., L. M.
Quercus sp.	×					
Sequoia angustifolia					×	× U. E., L. M.
Taxodium distichum miocenum		×				
occidentale				×		× U. E., L. M.
Vaccinophyllum questum			×			
Total=24	8	1	1	9	6	10
						10= U. E. 7= L. M.

From the analysis thus presented it appears that there are nine cases of Lignite Tertiary plants against six for the Miocene; but in the Oligocene there are ten cases, of which ten are Upper Eocene and seven also Lower Miocene. Hence, in spite of *Carpinus grandis*, which is chiefly Miocene, and of *Sequoia angustifolia* which is wholly Miocene, it must be concluded that the evidence is strongly in favour of an Oligocene age, with a pronounced tendency toward an Eocene, rather than a Miocene, affinity. It must, therefore, be concluded that the horizon indicated is Lower Oligocene or Upper Eocene, a conclusion which makes the flora agree with that of Nine-mile creek.

TULAMEEN OR NORTH SIMILKAMEEN RIVER.

The flora of the Tulameen river is the third largest of the entire series, comprising 47 species and genera. Its geographical position would lead to the inference that it must be essentially the same as for Nine-mile creek and the Similkameen river as a whole. The following analysis will show its relations.

DISTRIBUTION OF THE TULAMEEN FLORA—*Concluded.*

——	Excluded Genera.	General Distribution.	Wholly Tulameen.	Eocene Lig. Ter.	Miocene.	Oligocene.
Acer sp.	×					
Æsculus sp.	×					
Ailanthophyllum incertum			×			
Alnites curta					×	× U. E.
Alnus alaskana				× ?		
Aralia notata				×	×	× U. E.
Betula sp.	×					
Carpinus grandis				×	× Chf.	× U. E., L. M.
Carpolithes sp.	×					
Ceanothus sp.	×					
Comptonia diforme						× U. E., L. M.
partita				×		
Cornus suborbifera				×		× U. E.
Cratægus tulameenensis			×			
Cyperites sp.	×					
Ficus asiminæfolia					×	× L. M.
populina					×	× U. E.
Gingko sp.	×					
adiantoides				×	×	× U. E., L. M.
Glyptostrobus europæus		×				
Magnolia sp	×					
Musophyllum complicatum						× U. E.
Osmunda heerii					×	× U. E.

DISTRIBUTION OF THE TULAMEEN FLORA.

——	Excluded Genera.	General Distribution.	Wholly Tulameen.	Eocene Lig. Ter.	Miocene.	Oligocene.
Paliurus sp.	×					
Pinus sp.	×					
truncatus						× U. E., L. M.
tulameenensis			×			
Planera longifolia						× U. E., L. M.
Populus cordata				×	×	× U. E.
cordifolia, Cret.				×		
cuneata				×	×	× L. M.
latior				×	×	× U. E.
latior cordifolia				×		
zaddachi				×		× U. E., L. M.
Potamogeton verticillatus						× U. E.
Quercus dallii				× ?		
laurifolia				×		
Salix tulameenensis			×			
Sequoia sp.	×					
angustifolia				×	×	× U. E., L. M.
brevifolia				×		× U. E., L. M.
heerii					×	× U. E., L. M.
langsdorfii, Cret.				×		× U. E., L. M.
Taxodium distichum miocenum		×				
Typha latissima				×		× U. E., L. M.
Ulmus sp.	×					
minuta					×	× U. E.
Total = 47	12	2	4	18	13	23

21 = U. E.; 13 = L. M.....

The results derived from this analysis leave no opportunity for difference of opinion. There are eighteen species distinctively Eocene, ranging chiefly in the Lignite Tertiary, but probably also running higher, and thirteen which are Miocene. On the other hand there are no less than 23 species which are clearly Oligocene. An examination of this horizon still further shows that out of the 23, 21 are Upper Eocene while only 13 are Lower Miocene. Nine are distinctively Upper Eocene, while only two are as distinctively Miocene. On the other hand there are eleven which are both Eocene and Miocene, or represent the Oligocene proper. Thus :—

Distinctively Eocene, chiefly Lignite Tertiary	18
Distinctively Miocene	13
Oligocene	
Upper Eocene	21
Lower Miocene	13
Distinctively Upper Eocene	9
Distinctively Lower Miocene	2
Oligocene proper	11
Thus giving	
Eocene	48
Miocene	28

And when to this result we join the eleven which are both Upper Eocene and Lower Miocene, it seems that the position of the Tulameen must be regarded as Oligocene, possibly a little higher if anything than the horizon assigned to the Similkameen and Nine-mile creek.

STRATIGRAPHICAL DISTRIBUTION OF TERTIARY PLANTS IN BRITISH COLUMBIA AND OTHER PARTS OF WESTERN CANADA

STRATIGRAPHICAL DISTRIBUTION OF TERTIARY PLANTS IN BRITISH

	Upper Laramie, Lower Eocene or Lignite Ter-								
	Porcupine Creek, etc.	Saskatchewan.	Calgary.	Cochrane.	Red Deer River.	Mackenzie River.	Edmonton.	Burrard Inlet.	Omineca River.
Acer sp.								×	
dubium, Penh.									
grossedentatum, Heer.									
trilobatum productum, Heer.									
Acerites negundifolium, Dn									
Æsculophyllum hastingsense, Dn								×	
Æsculus sp.	×								
antiquus, Dn.	×	×							
Ailanthopyllum incertum, Dn									
Alnites curta, Dn.									
grandifolia, Newb.					×				
Alnus sp.									
alaskana, Newb.									
carpinioides, Lesq.									
serrulata fossilis, Newb.									
Amygdalus gracilis, Lesq.									
Andromeda delicatula, Lesq.									
Antholithes sp.									
amissus, Heer.						×			
Aralia acerifolia, Lesq.									
notata? Lesq.									
Arundo sp.									×
Asplenites sp.								×	
Azollophyllum primævum, Penh.									
Betula sp.								×	
angustifolia, Newb.									
heterodonta, Newb.									
macrophylla, Goepp						×			
prisca? Ett.									
stevensoni, Lesq.									
Callistemophyllum latum, Dn.						×			
Carex sp.									
burrardiana, Penh.								×	

TIARY.			UPPER EOCENE.						OLIGOCENE.		LOWER MIOCENE.		
			Oligocene.										
Finlay River.	Coal Brook.	Blackwater River.	Quesnel.	Quilchena.	Horsefly River.	Coal Gully.	Similka-meen River.	Nine-mile Creek.	Kettle River.	Tulameen River.	Stump Lake.	Tranquille River.	Kamloops.
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	Upper Laramie, Lower Eocene or Lignite Ter-								
—	Porcupine Creek, etc.	Saskatchewan.	Calgary.	Cochrane.	Red Deer River.	Mackenzie River.	Edmonton.	Burrard Inlet.	Omineca River.
Carex vancouverensis, Penh.								×	
Carpinus grandis, Ung									
Carpolithes sp.	×					×			
seminulum, Heer						×			
dentatus, Penh									
Carya sp.									
antiquorum, Newb	×				×				
Castanea sp.	×								
castaneæfolia (Ung.), Kn									
intermedia ? Lesq									
Catalpa crassifolia, Newb.	×				×				
Ceanothus sp.									
Cercis parvifolia, Lesq					×				
Cinnamomum affine, Lesq									
Clintonia oblongifolia, Penh.					×				
Comptonia diforme (Sternb.), Berry									
dryandroides, Ung									
partita (Lesq.), Berry									
quilchenensis n. sp.									
Cornus newberryi, Hollick									
suborbifera ? Lesq									
Cornus rhamnifolia, O. Web					×				
Corylus sp.									
americana, Walt	×				×				
maquarrii (Forbes), Heer	×				×	×			
rostrata, Ait	×								
Cratægus tranquillensis n. sp.									
tulamcenensis n. sp.									
Cupressoxylon sp.							×		
dawsoni, Penh.	×								
macrocarpoides, Penh.									
Cyperites sp.									

COLUMBIA AND OTHER PARTS OF WESTERN CANADA—*Continued.*

TIARY.			UPPER EOCENE.						OLIGOCENE.		LOWER MIOCENE.		
			Oligocene.										
Finlay River.	Coal Brook.	Blackwater River.	Quesnel.	Quilchena.	Horsefly River.	Coal Gully.	Similkameen River.	Nine-mile Creek.	Kettle River.	Tulameen River.	Stump Lake.	Tranquille River.	Kamloops.
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	Upper Laramie, Lower Eocene or Lignite Ter-								
	Porcupine Creek, etc.	Saskatchewan.	Calgary.	Cochrane.	Red Deer River.	Mackenzie River.	Edmonton.	Burrard Inlet.	Omineca River.
Cyperites haydenii, Lesq									
paucinervis, Heer								×	
Davallia tenuifolia, Sw.	×								
Diospyros alaskana? Schimp									
Dombeyopsis islandica, Heer									
Dryophyllum stanleyanum, Dn									
Equisetum sp.	×								
arcticum, Heer	×				×				
parlatorii, Schimp						×			
similkameenense, Dn									
Fagus antipofi, Abich									
feroniæ, Ung									
Fern stipes									
Ficus sp.					×				
asarifolia? Ett									
asiminæfolia, Lesq									
decandolleana, Heer									
occidentalis? Heer								×	
populina, Heer									
shastensis? Lesq								×	
spectabilis? Lesq						×			
tiliæfolia, Brongn						×			
ungeri, Lesq									
Gingko sp.	×					×			
adiantoides (Ung.), Heer	×								
digitata (Brongn.), Heer									
Glyptostrobus									
europæus (Brongn.), Heer	×				×	×			
Grass seeds									
Grewia sp.									
crenata (Ung.), Heer									
Hedera maclurii, Heer						×			

COLUMBIA AND OTHER PARTS OF WESTERN CANADA—*Continued.*

TIARY.			UPPER EOCENE.						OLIGOCENE.		LOWER MIOCENE.		
			Oligocene.										
Finlay River.	Coal Brook.	Blackwater River.	Quesnel.	Quilchena.	Horsefly River.	Coal Gully.	Similkameen River.	Nine-mile Creek.	Kettle River.	Tulameen River.	Stump Lake.	Tranquille River.	Kamloops.
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	Upper Laramie, Lower Eocene or Lignite Ter-								
—	Porcupine Creek, etc.	Saskatchewan.	Calgary.	Cochrane.	Red Deer River.	Mackenzie River.	Edmonton.	Burrard Inlet.	Omineca River.
Hypnum columbianum, Penh.									
Juglans sp.					×				
acuminata, A. Br					×	×			
cinerea? L.	×								
crossii, Kn.								×	
leconteana, Lesq.					×				
laurifolia, Kn.					×				
nigella, Heer.									
occidentalis, Newb.					×				
rhamnoides, Lesq.	×								
rugosa, Lesq.	×								
schimperi, Lesq.	×								
Larix johnseni, Schrœter						×			
Lastrea fischeri, Heer.					×			×	
Leguminosites ?									
arachioides, Lesq.									×
borealis, Dn.						×			
Lemna scutata, Dn.	×							×	
Lygodium kaulfussii, Heer.								×	
Magnolia sp.									
nordenskioldii, Heer						×			
Maianthemum grandifolium, Penh.					×				
Manicaria sp.								×	
Musophyllum complicatum, Lesq.									
Myrica sp.									
Myrica sp.									
personata ? Kn.									
Nelumbium sp									
pygmæum, Dn.									
saskatchuense, Dn					×				
Neuropteris civica, Dn.								×	
Nordenskioldia borealis, Heer.						×			

COLUMBIA AND OTHER PARTS OF WESTERN CANADA—*Continued.*

TIARY.			UPPER EOCENE.						OLIGOCENE.		LOWER MIOCENE.		
			Oligocene.										
Finlay River.	Coal Brook.	Blackwater River.	Quesnel.	Quilchena.	Horsefly River.	Coal Gully.	Similka-meen River.	Nine-mile Creek.	Kettle River.	Tulameen River.	Stump Lake.	Tranquille River.	Kamloops.
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—	UPPER LARAMIE, LOWER EOCENE OR LIGNITE TER-								
	Porcupine Creek, etc.	Saskatchewan.	Calgary.	Cochrane.	Red Deer River.	Mackenzie River.	Edmonton.	Burrard Inlet.	Omineca River.
Nyssidium sp.									
Onoclea sensibilis, L.	×				×				
Osmunda heerii, Gaudin									
macrophylla n. sp.					×				
Paliurus sp.									
colombi, Heer	×								
Phragmites sp.	×								
Phyllites sp	×								
aroideus, Heer.						×			
cupanioides, Newb.	×								
carneosus, Newb.					×				
venosus, Newb.	×				×				
Picea columbiensis, Penh.									
tranquillensis n. sp.									
quilchenensis n. sp.									
Pinus sp.									
columbiana, Penh									
lardyana, Heer									
steenstrupiana, Heer.						×			
trunculus, Dn.									
tulameenensis n. sp.									
Planera crenata, Newb								×	
longifolia, Lesq									
Platanus sp.								×	
aceroides, Goepp.						×			
haydenii, Newb	×								×
heterophyllus, Newb	×								
nobilis, Newb.	×				×				
raynoldsii, Newb.	×								
Podocarpites tyrrellii, Dn.					×				
Populus sp.									
acerifolia, Newb.	×				×				

COLUMBIA AND OTHER PARTS OF WESTERN CANADA—*Continued.*

TIARY.			UPPER EOCENE.						OLIGOCENE.		LOWER MIOCENE.		
			Oligocene.										
Finlay River.	Coal Brook.	Blackwater River.	Quesnel.	Quilchena.	Horsefly River.	Coal Gully.	Similkameen River.	Nine-mile Creek.	Kettle River.	Tulameen River.	Stump Lake.	Tranquille River.	Kamloops.
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	Upper Laramie, Lower Eocene or Lignite Ter-								
	Porcupine Creek, etc.	Saskatchewan.	Calgary.	Cochrane.	Red Deer River.	Mackenzie River.	Edmonton.	Burrard Inlet.	Omineca River.
Populus arctica, Heer	×	....	....	....	×	×	....	....	×
arctica latior, Heer	....	....	....	....	....	×	....	....	....
balsamoides, Goepp	....	....	....	....	....	....	....	×	....
cordata, Newb	....	....	....	....	....	....	....	....	....
cordifolia, Newb	....	....	....	....	....	....	....	....	....
cuneata, Newb	×	....	....	....	×	....	....	....	....
daphnogenoides ? Ward	....	....	....	....	×	....	....	....	....
genetrix, Newb	....	....	....	....	×	....	....	....	....
hookeri, Heer	×	....	....	....	....	×	....	....	....
latior, A. Br.	....	....	....	....	....	×	....	....	....
latior cordifolia, Heer	....	....	....	....	....	....	....	....	....
mutabilis oblonga, Heer	....	....	....	....	....	....	....	....	....
nebrascensis, Newb	....	....	....	....	....	....	....	....	....
nervosa, Newb	....	....	....	....	×	....	....	....	....
obtrita, Dn.	....	....	....	....	×	....	....	....	....
polymorpha, Newb	....	....	....	....	....	....	....	....	....
richardsoni, Heer	×	....	....	....	×	×	....	....	....
rotundifolia, Newb	....	....	....	....	....	....	....	×	....
speciosa, Ward	....	....	....	....	....	....	....	....	×
subrotunda, Lesq	....	....	....	....	....	....	....	....	....
ungeri, Lesq	....	....	....	....	×	....	....	....	....
zaddachi, Heer	....	....	....	....	....	....	....	....	....
Potamogeton sp	....	....	....	....	....	....	....	....	....
verticillatus, Lesq	....	....	....	....	....	....	....	....	....
Prunus merriami, Kn	....	....	....	....	....	....	....	....	....
Pseudotsuga miocena, Penh	×	....	....	....	....	....	....	....	....
Pteris sitchensis, Heer	....	....	....	....	....	×	....	....	....
Pterospermites sp	....	....	....	....	....	....	....	....	....
spectabilis, Heer	....	....	....	....	....	×	....	....	....
cupanioides (Newb.), Kn	×	....	....	....	....	....	....	....	....
Pyrus sp	....	....	....	....	....	....	....	....	....
Quercus sp	×	....	....	....	×	....	....	....	....

COLUMBIA AND OTHER PARTS OF WESTERN CANADA—*Continued.*

TIARY.			UPPER EOCENE.						OLIGOCENE.		LOWER MIOCENE.		
			Oligocene.										
Finlay River.	Coal Brook.	Blackwater River.	Quesnel.	Quilchena.	Horsefly River.	Coal Gully.	Similkameen River.	Nine-mile Creek.	Kettle River.	Tulameen River.	Stump Lake.	Tranquille River.	Kamloops.
...	×	...	×	...	...	...	...	×	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	×	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	×	...	...	...
...	...	...	...	...	...	...	...	...	...	×	...	...	...
...	...	...	...	...	...	...	...	...	...	×	...	×	...
...	...	...	...	...	...	...	×	...	...	...	...	...	...
...	×	...	...	×	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	×	...	...	×	...	×	...	...	...
...	...	...	...	...	...	...	...	...	...	×	...	...	...
...	...	...	...	×	...	...	...	...	...	...	...	×	...
...	...	...	...	×	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	×	...	...	×	...	...	...	...	...	...
...	...	...	...	...	...	×	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	×	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	×	...	...	...	...	...	...	...	...	...	...	...	...
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...	...	...	...	...	...	...	×	...	...	×	...	×	...
...	...	...	...	...	...	...	...	...	×	...	...	...	...
...	...	...	...	...	...	...	...	...	...	×	...	...	...
...	...	...	...	×	...	...	...	...	...	...	...	...	...
...	...	...	...	...	×	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
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...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	×	...	...	...	...	...	...	...	...
...	...	...	×	...	×	...	×	...	...	...	...	...	...

	Upper Laramie, Lower Eocene or Lignite Ter-								
——	Porcupine Creek, etc.	Saskatchewan.	Calgary.*	Cochrane.	Red Deer River.	Mackenzie River.	Edmonton.	Burrard Inlet.	Omineca River.
Quercus antiqua, Newb.	×								
castaneopsis, Newb.									
consimilis, Newb.									
dallii, Lesq.									
dentoni, Lesq								×	
ellisiana, Lesq.					×				
laurifolia? Newb.									
pseudocastanea? Goepp.									
Rhamnacinium porcupinianum, Penh.	×								
triseriatim, Penh.	×								
Rhamnites concinnus, Newb.	×								
Rhamnus sp.									
elegans, Newb.									
eridani, Ung.									
gaudini, Heer.									
quilchenensis n. sp.									
Rhus rosæfolia? Lesq.									
Sabalites									
campbellii (Newb.), Kn.								×	
Salix integra, Goepp.								×	
kamloopsiana, Dn.									
laramiana, Dn.	×				×				
orbicularis n. sp.									
perplexa, Kn.									
racana, Heer.	×					×			
tulameenensis n. sp.									
varians, Goepp.								×	
Sapindus sp.					×				
affinis, Newb.	×								
Sassafras sp.									
burpeana, Dn.	×								
selwynii Dn.	×								

COLUMBIA AND OTHER PARTS OF WESTERN CANADA—*Continued.*

TIARY.			Upper Eocene.						Oligocene.		Lower Miocene.		
			Oligocene.										
Finlay River.	Coal Brook.	Blackwater River.	Quesnel.	Quilchena.	Horsefly River.	Coal Gully.	Similkameen River.	Nine-mile Creek.	Kettle River.	Tulameen River.	Stump Lake.	Tranquille River.	Kamloops.
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	×	...	...	...	...	...	...	...	...	...
...	...	...	...	×	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	×	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	×	...	...	...
...	...	...	×	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	×	×	...	...	...	...	...	...	...	...	...
...	...	...	...	×	×	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	×	...
...	...	...	...	×	...	...	...	...	...	...	...	...	...
...	...	...	...	×	×	...	...	...	...	...	...	...	...
...	×	...	...	...	...	...	...	...	...	...	...	...	...
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...	...	...	...	...	...	...	...	...	...	...	...	...	×
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...	...	...	...	×	...	...	...	...	...	...	...	...	...
...	...	...	...	×	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	×	...	...	...
...	...	...	...	×	×	...	...	...	...	...	...	×	...
...	...	...	...	...	...	...	...	×	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	×	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...

	Upper Laramie, Lower Eocene or Lignite Ter-								
——	Porcupine Creek, etc.	Saskatchewan.	Calgary.	Cochrane.	Red Deer River.	Mackenzie River.	Edmonton.	Burrard Inlet.	Omineca River.
Scirpus sp.	×								
Sequoia sp.									
angustifolia, Lesq.									
brevifolia, Heer.									
burgessii, Penh.	×								
couttsiæ, Heer.					×				×
heerii, Lesq.									
langsforfii (Brongn.), Heer.	×				×	×			×
nordenskioldii, Heer.	×				×	×			
Sphenopteris blœmstrandi, Heer					×				
guyottii, Lesq.					×				
Sphenozamites oblanceolatus n. sp.					×				
Symphorocarpophyllum sp.	×								
albertum, Dn.				×					
linnæforme, Dn.	×								
Taxodium distichum miocenum, Heer.	×			×	×	×		×	
laramianum, Penh.				×					
occidentale, Newb.	×				×	×			
Taxites olriki, Heer.	×					×			
Taxus sp.							×		
Thuya interrupta, Newb.	×								
Trapa borealis, Heer.	×								
microphylla, Lesq.	×								
Typha sp.	×				×				
latissima, A. Br.					×				
Ulmus sp.									
columbiensis, Penh.									
minuta, Goepp.									
præcursor, Dn.	×								
proto-americana, Penh.									
proto-racemosa, Penh.									
speciosa, Newb.									

COLUMBIA AND OTHER PARTS OF WESTERN CANADA—*Continued.*

TIARY.			UPPER EOCENE.						OLIGOCENE.		LOWER MIOCENE.		
			Oligocene.										
Finlay River.	Coal Brook.	Blackwater River.	Quesnel.	Quilchena.	Horsefly River.	Coal Gully.	Similkameen River.	Nine-mile Creek.	Kettle River.	Tulameen River.	Stump Lake.	Tranquille River.	Kamloops.
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	×	×	...	...	...	...	×	...	×	...
...	...	...	...	×	×	...	×	...	...	×	...	×	...
...	...	...	...	...	...	...	...	×	...	×	...	×	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
×	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	×	×	...	...	...	...	×	...	×	...
×	...	×	...	...	...	×	...	×	...	×	...	×	...
...	...	...	...	×	×	...	...	...	...	...	...	...	...
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...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	×	×	×	×	×	...	×	×	×	×	...
...	...	...	...	...	×	...	...	...	...	...	...	...	...
...	...	×	...	×	×	...	×	...	...	...	...	×	...
...	...	...	...	×	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	×	×	...	×	...	...	...	×	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	×	×	...	...	...	×	...	×	...
...	×	...	...	...	...	...	...	...	×	×	...	...	...
...	...	...	...	...	...	...	...	...	×	...	...	...	...
...	...	...	...	...	×	...	...	...	...	×	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	×	...	...	...	...
...	...	...	...	...	...	...	...	...	×	...	...	...	...
...	...	...	...	×	×	×	...	...	...	...	...	...	...

	UPPER LARAMIE, LOWER EOCENE OR LIGNITE TER-								
	Porcupine Creek, etc.	Saskatchewan.	Calgary.	Cochrane.	Red Deer River.	Mackenzie River.	Edmonton.	Burrard Inlet.	Omineca River.
Ulmus tenuinervis, Lesq									
Vaccinophyllum questum, Dn.									
Viburnum asperum, Newb.	×				×				×
calgarianum, Dn.			×						
dentoni, Lesq.									
lanceolatum, Newb.	×								
ovatam, Penh.					×				
oxycoccoides, Dn.	×								
lakesii, Lesq.	×								
pubescens, Pursh.	×								
saskatchuense, Dn.		×			×				
Vitis olriki, Heer.									
rotundifolia, Newb.									
Zanthoxylum spireæfolium, Lesq.									

COLUMBIA AND OTHER PARTS OF WESTERN CANADA—*Concluded.*

TIARY.			UPPER EOCENE.						OLIGOCENE.		LOWER MIOCENE.		
			Oligocene.										
Finlay River.	Coal Brook.	Blackwater River.	Quesnel.	Quilchena.	Horsefly River.	Coal Gully.	Similkameen River.	Nine-mile Creek.	Kettle River.	Tulameen River.	Stump Lake.	Tranquille River.	Kamloops.
												×	
						×							
×													
												×	
					×								
				×									
				×									

The general conclusions thus reached as to the age of the plant-bearing beds of British Columbia are, in the main, in accord with views already expressed by Sir William Dawson, who observed that the plants of the Similkameen valley were Miocene, or possibly Oligocene [1]. The more northern localities, such as Coal brook at the North Thompson Indian reserve, the Omineca, Finlay and Blackwater rivers, he did not discuss at all. It would thus appear, so far as plant remains are concerned, that the main body of Tertiary deposits in British Columbia must be Oligocene or nearly so, but it will be well to ascertain what evidence, if any, is to be derived from animal remains, especially those of fish.

Lambe[2] has recently contributed an important paper upon this subject, in which he not only reviews the conclusions of Cope, derived from a study of *Amyzon brevipinne*, Cope, but brings forward new evidence to show that this same, as well as another species, occurs in the Tertiary beds of the Horsefly river.

In 1894, Cope pointed out[3] the occurrence of *Amyzon brevipinne* in the Tertiary of Colorado, but was at that time unable to determine whether or not they were of the Eocene or Miocene series. The subsequent discovery of the same species in the Tertiary area of British Columbia enabled him to correlate the Colorado and Nevada beds with those of the Similkameen in Canada. It was largely due to this correlation, that Dr. G. M. Dawson was led to consider the whole Tertiary formation of southern British Columbia as probably of Oligocene (Upper Eocene) age.[4]

More recently, Lambe has been able to recognize not only *A. brevipinne*, but also *A. commune*, Cope, in the Tertiary beds of the Horsefly river. The occurrence of this fish offers very strong evidence as to the Oligocene age of those deposits.

A comparison of the localities in which Amyzon has been found, with the age of such beds as determined by plant remains, will show what correspondence there may be.

	Amyzon.		Plants.		
—	Oligocene Upper Eocene.	Eocene Probably Upper.	Oligocene Upper Eocene	Oligocene proper.	Oligocene Lower Miocene ?
Tulameen river	x			x	
Tranquille river	x				x
Kamloops					x
Horsefly river	x		x		
Quesnel		x			

From this presentation it will appear that the evidence derived from the plants and from Amyzon is substantially in accord, and the conclusion may therefore be reached that the horizons indicated by the floras are in the main correct and of Oligocene age.

1 Trans. R.S.C., VIII, 1890, iv, 75.
2 *Ibid*, N.S., XII, 1906, iv, 151–156.
3 The Vertebrata of the Tertiary formations of the West. U.S. Geol. Surv. Terr., 1884, XXXV,
4 Kamloops Map Sheet, Geol. Surv. Can., 1877–78, 76.

In leaving this part of our subject it may be remarked that whatever error there may be, arising from the methods involved, or from a possible confusion of strata, the general tendency has been to place Stump lake, the Tranquille river and Kamloops in a somewhat too high horizon: and it may eventually be found that these should be placed in the same horizon as Tulameen river, and Kettle river. This error, if any, is slight, and does not materially alter the general conclusion.

COMBUSTION OF LIGNITE BEDS.

An important feature of the lignite beds throughout the entire area of the Bad Lands of Dakota, Montana and Saskatchewan, as well as in the Mackenzie River area and various parts of British Columbia, is presented by their combustion. This phenomenon was observed in 1848 by Sir John Richardson on the occasion of his Arctic Searching Expedition[1], who refers to the fact that "The smoke, with flame visible at night, has been present in some part or other of the formation ever since," referring in this way to the statement of Mackenzie who is said to have observed these fires in 1785, and whose account of them was probably the first record of their occurrence. The phenomenon was first observed at Bear river, and Richardson was able to note the same combustion of bituminous shales in latitude 70° 19′ N. He comments upon the frequent occurrence of indurated clays and biscuit porcelain caused by the action of such fires upon superimposed strata.

More recently various exploring expeditions have taken cognizance of the destruction of the lignite upon a gigantic scale. Thus the expedition under Dr. F. V. Hayden[2] contains very full accounts by himself and his associates of the physical features of the country as determined by metamorphosis of clay and sandstone deposits with subsequent erosion of the softer parts.

Lewis and Clarke[3] commented upon the occurrence of large quantities of pumice on the Missouri river, about fifty miles above the Heart river "which had every appearance of having been at some time on fire". They had previously observed the occurrence of "burnt hills" about half way between the mouths of the Tongue and Powder rivers on the Yellowstone, at which point the Powder River region of matamorphism begins.

A scientific explanation of the origin of these fires does not seem to have been attempted until 1873. Mr. J. A. Allen[4] who was attached to the Northern Pacific Railroad Expedition under General Stanley as zoologist had an opportunity to inquire more closely into all the related conditions.

A further study of the same phenomenon as developed in Canada was made in 1873–74 by Dr. G. M. Dawson and published in 1876 in connexion with the Report of the British North American Boundary Commission[5]. The report takes cognizance of the conclusions previously reached by Mr. Allen, but a different interpretation is placed upon the active causes. In view of the divergence of opinion expressed by these two observers, and particularly in the light of evidence which has recently become available[6], it seems desirable to review the

1 Arctic Searching Expedition, London, 1851, pp. 189, 191, 271, 195,

2 Geol. Rept., Explor. Missouri and Yellowstone, 1869. p. 56, etc.

3 Lewis and Clarke, Explor. Exped. Vol. II. pp. 173, 393.

4 Metamorphism Produced by the burning of Lignite beds in Dakota and Montana Territories, Proc. Bos.. Soc. Nat. Hist., XVI, 1874, 246.

5 Report on the Geology and Resources of the Region in the vicinity of the Forty-ninth Parallel, Montreal, 1875.

6 A Blazing Beach. Science, N. S. XXII, 1905, 794-796: Pop. Sci. M. LXX. 1907, 557-564.

salient features of the data in order to ascertain, if possible, (1) the probable causes of such fires: and (2) the probable connexion between conflagrations of this kind and certain metamorphosed, plant-bearing rocks of Tertiary age, to be met with in various parts of British Columbia, as well as in the eastern lignite area.

The Bad Lands of the Upper Missouri and its tributaries owe their very remarkable character and extremely interesting features to the presence of highly metamorphosed clays and sands, accompanied by pumiceous and lava-like materials, undistinguishable in character from true volcanic products, but occurring over an extensive area, remote from any region of true volcanic action. This metamorphosis is solely the result of the burning out of beds of lignite co-extensive with the Bad Lands of the Lignite Tertiary.

This formation extends, in the United States, from near the 100th to about the 108th meridian, and from the 43d to beyond the 49th parallel, or over an area of about 500 miles in an east and west direction, and more than 30 miles north and south. Its southern border is quite irregular, being broken into by the Black hills, between which and the Big Horn mountains it extends southward as far as the 43d parallel. An outlying district west of the main chain of the Rocky mountains, on the Gros Ventres fork of the Snake river, is also referred to. At the time of these observations, although the extension of the Lignite Tertiary into the valleys of the Saskatchewan and Mackenzie rivers was well known, there were no data at hand which would permit of tracing the phenomena of metamorphism much to the northward of the Missouri river. But the results reached by Dawson[1] would seem to indicate that to the 185,500 square miles of territory in the United States, there must be added at least 53,000 square miles for Canada, making a total of 238,500 square miles occupied by the Lignite Tertiary formation. Within this area the lignite occurs in beds from a few inches to eighteen feet in thickness, and the quality varies from a mere carbonaceous shale to a texture so compact and dense as to present the general appearance of cannel coal.

The lignite seams are overlaid by beds of sand or clay containing recognizable remains of plants, often in a very beautiful state of preservation, and some of these have been accurately figured by Sir John Richardson in his report for 1851. There are also alternating metamorphosed beds of greyish cinders, pumiceous matter, clinkers and indurated clay of a bright brick red colour, varying in thickness from a few feet to twenty or more. The yielding nature of the horizontal strata has permitted the material to be excavated by streams, and the entire country is traversed by deep channels and numerous gullies, varying in depth from one hundred to three or four hundred feet, and so extensive that only narrow ridges and isolated buttes, with their naked and almost vertical slopes, are left to indicate the former general level. Dawson observes that[2]; "in no part of the world does the destruction of mineral fuels seem to have occurred on so vast a scale as in the central plateau of this continent. The appearances produced by this action were found in almost all localities in which lignite occurred"; and from the data given by both Allen and Dawson the metamorphosed area would seem to embrace no less than 8,000 square miles. The alteration extends much farther above the position of the lignite beds than below it. The layers immediately above the lignite are frequently altered to hard, jaspery or porcelain-like rock breaking with a conchoidal fracture, and in this substance impressions of stems and leaves of plants are sometimes recognizable.

1 Brit. N. A. Bound. Comm., p. 152.
2 Brit. N.A. Bound. Comm., p. 164.

From the evidence thus at hand it would seem that so far as the eastern lignite area is concerned the metamorphosis has been determined entirely by the combustion of lignite, and no doubt the same explanation holds true to some extent of those in British Columbia, although to this there has been added the effect of volcanic action.

In endeavouring to account for the fires which produced these results Allen[1] considers that more than one cause may have been operative, and he recalls well known instances of beds which had been ignited by the burning of prairie grass by Indians, in some cases the fires lasting for several years, in others until they were extinguished by the rising river. Dawson[2] similarly refers to the fires of Indians or traders' camps, as well as to prairie fires as the known cause in some instances. With respect to the latter, he points out that even when burning over very scantily grassed areas there is sufficient heat to ignite the *bois de vaches*, or dried Buffalo excrement, with which the surface is strewn —a much less combustible fuel; and he considers this a wholly satisfactory explanation.

Allen, on the other hand, attaches importance to the theory of spontaneous combustion originally suggested by Nicollet[3], supposed to be due to the percolation of atmospheric waters upon beds of pyrite which in their decomposition generated sufficient heat to fire the lignite. In opposition to this view Dawson points out that this is not properly spontaneous combustion, and that while the ignition of bituminous beds is well known to be due to the oxidation of pyrites, this can hardly be applied to the lignite beds, which a chemical analysis shows to be almost entirely devoid of that mineral. Dawson has also cited instances of lignite beds burned at the outcrop only[4], a fact which may be interpreted to mean that the fire had been extinguished before making great headway, or that the absence of oxygen in the interior of the beds had prevented its extension in that direction. But Allen, on the other hand, shows conclusively[5] that the fire very generally extended throughout the entire bed and generated large quantities of explosive gases which developed great pressure. This is evident from the occurrence of numerous volcanic chimneys which reproduce in miniature all the features of active volcanoes, but have their origin in the lignite beds.

There is a manifest want of agreement in the interpretation of all the observed facts. It is quite clear that the lignite does burn independently of fresh supplies of oxygen, and that it must be capable of ignition otherwise than through the agency of man or prairie fires. It is equally clear that there is not sufficient pyrite present to cause such a conflagration by its oxidation. Some other cause must be sought.

Allen expresses the opinion that the peculiar metamorphosis exhibited by the lignite beds has extended back to a very remote period[6], and that its beginning must have been anterior to the close of the drift period, (Op. cit.), and prior to the terrace epoch. His reason for this opinion is based upon the fact that igneous material in a water-worn state occurs in the drift which covers the general surface of the country, often many miles from the nearest seat of metamorphic action, as well as in the terraces that border the larger streams.

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1 Proc. Bost. Soc. Nat. Hist., 261.
2 Brit. N.A. Bound. Comm.
3 Rep. Hydrogr. Basin Upper Missouri, p. 140.
4 Brit. N.A. Bound. Comm., p. 165, pl. IV, f. 1.
5 Proc. Bost. Soc. Nat. Hist., p. 249.
6 Proc. Bost. Soc. Nat. Hist.

The occurrence of fires in the lignite beds is a phenomenon by no means peculiar to them, since there is abundant evidence of other conflagrations as early as the Cretaceous, and extending thence down to the present time, and well within the knowledge of those now living. The origin of such fires has been traced to a well defined cause which throws a great deal of light upon the combustion of the lignite beds, and may possibly serve as an adequate explanation.

In 1905, Penhallow[1] gave a detailed account of a conflagration upon a beach at Kittery point, Maine, which, according to the evidence, was due to the spontaneous combustion of gases originating in the decomposition of organic debris, chiefly vegetable, buried in the underlying sands. A further study of the circumstances surrounding the event, and of the structure of the beach itself, confirmed the conclusions first reached, and permitted an explanation of the probable origin of many obscure forest fires[2]. The facts thus set forth have also led to a satisfactory explanation of forest fires which have left their records in formations as remote as the Cretaceous.

In 1905, Dr. Arthur Hollick directed attention to the presence of charred wood in the Cretaceous deposits at Kreischerville, Staten island, New York, and drew the inference that since man was not in existence at that time the fire must have been due to some natural agency such as lightning[3]. This explanation, however, has not been regarded as satisfactory, though it was adopted tentatively, because of the absence of positive testimony in any other direction, and also because the occurrence of fires in widely separated localities of approximately the same geological age could not be accounted for through the medium of such an agency. On a more recent occasion[4] he informs us that a careful study of the Kreischerville deposits indicates very clearly that the original conditions of deposition must have been strikingly similar to those described as existing at the Kittery Point beach, and he therefore finds the explanation of the Kittery phenomenon to afford a wholly satisfactory solution of the way in which fires originated in Cretaceous time.

Some years ago Dr. G. F. Matthew of St. John, New Brunswick, described a forest fire which had spread over the surface of a bog about 2,000 years ago[5]. A careful consideration of all the circumstances set forth in that account renders it highly probable that that fire also had its origin in the spontaneous combustion of gases generated in the bog itself, these gases taking fire as soon as they reached the surface and came into contact with air.

Dr. Dawson has assigned as one of the possible causes of fires in the lignite beds the "spontaneous combustion of the lignite when undergoing decomposition at the outcrop[6], but as he overlooks the possible presence of combustible gases, and conceives such decomposition to involve iron pyrites only, he rejects the explanation as highly improbable.

Lignite beds are precisely such deposits as would be associated with the presence of sulphuretted hydrogen, the light carburetted hydrogen and phosphuretted hydrogen. How long it would be possible for such gases to be stored in the strata where formed, or in those adjacent thereto, is open to question, and does not materially affect the answer sought. But

[1] Science, N.S., XXII, 1905, 794-796.
[2] Pop. Sci. M., LXX, 1907, 557-564.
[3] Proc. Nat. Sci. Ass'n. S.I. IX, 1905, 35-36.
[4] Proc. S. I. Ass'n. Arts and Sciences, I, 1906, 21.
[5] Can. Rec. Sci., VIII, 1900, 213-218.
[6] Brit. N. A. Bound. Comm., 1875, 168.

known instances of their storage in marsh turf and in coal seams indicates that there should be no difficulty in assuming their presence and continual accumulation in the lignite beds. With the denudation of the general area, and the exposure of fresh bodies of lignite at various times, possibly at intervals of a few years, or again with intervals of centuries, the escaping gases would ignite and give rise to all the observed phenomena. While, therefore, it must be conceded that some of these conflagrations have undoubtedly had their origin in prairie fires or through the agency of man, others, and possibly most of them, have been due to the spontaneous ignition of escaping gases.

If, upon further investigation, this explanation is found to be satisfactory, it may also be possible to apply it to those Tertiary beds in British Columbia and other western areas where we find metamorphosed clays and standstones containing charred fragments of plants, the majority of which are wholly unrecognizable.

An application of these facts appears to be essential to a complete understanding of the conditions under which the Tertiary beds of British Columbia appear today, since there is reason to believe that the very remarkable changes in position, and the metamorphosis of the materials of these strata, have been brought about by volcanic activity supplemented by combustion of the lignite beds. How far one or the other of these causes has operated within given areas it is at present impossible to say, but a solution of this question is essential to a clear understanding of the sequence of strata and their floras, in a region where both the Cretaceous and Tertiary formations have undergone a remarkable readjustment incident to the elevation of the Rocky Mountain chain, involving in some cases an apparent mixture of the beds. The final explanation can be reached, in our opinion, only through an exact stratigraphical study of the floras and the rocks in which they are held. It will be profitable, however, to review some of the opinions already expressed, and the facts derived from actual field work, as bearing upon this question.

In 1875, Dr. Selwyn made the following observations[1] ;—

"The local development of volcanic rocks leaves the question open as to whether they have been removed by denudation, or to their never having extended over the entire region. The Lignite Tertiary strata, however, which at present are assumed to have preceded the latest of these volcanic outbursts, occupy undefined but certainly extensive areas between Fort George and McLeod lake, and probably continue thence to the valley of Nation river, with only such interruptions as are the result, partially of the original uneveness of the surface upon which they were laid down, and partly of the subsequent denuding agencies to which they have been subjected, giving rise to outcroppings of the older rocks either as hills or ridges rising above the general level of the country, or appearing as rocky bars or canyons in the deep cut channels of rivers."

In 1876 Dr. G. M. Dawson[2] states that, "On the south side of Tsacha lake, there are numerous fragments of shaly, Tertiary clays, some with obscure plant impressions, leading to the inference that the basalts of the region were cut through in its bed.

"Underlying the basalts are deposits of arenaceous clays, volcanic mud and pumice, together with diatomaceous clays, and in this formation there are grains of coniferous pollen. There is thus an interlocking of ordinary sedimentary and volcanic Tertiary products.

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1 Geol. Surv. Can., 1875-76, 71-72.
2 Geol. Surv. Can., 1876-77. 75-80.

"Numerous volcanic flows are now represented by dikes, and in their neighbourhood the beds are roughly brecciated. Many of these volcanic outcrops were produced prior to the glacial period."

In the following year the same author made the following statement:—

"Further and more detailed examination of the portion included in the Kamloops map sheet still fails to afford the necessary palæontological data for any complete subdivision of the Tertiary rocks. However, it is evident that the rocks collectively referred to as Tertiary represent a very long period of time, with several changes of condition, and that there are also probably one or more gaps, unrepresented so far as known by deposits of any kind. These general facts are established chiefly by stratigraphical and other physical characteristics and relations of the rocks, but they are borne out also, in a measure, by the slight evidence to be obtained from fossils. These consist almost exclusively of plant and insect remains, obtained from several localities, of which one of the most striking peculiarities is the diversity of each collection from the others."[1]

GENERAL SUMMARY AND CONCLUSIONS.

From the evidence presented in the foregoing pages it is evident that the Tertiary formation of British Columbia, as at present known, cannot be regarded as more recent than Lower Miocene, and that the greater portion of the beds is of Oligocene age. Upon this point Sir William Dawson[2] has already observed that "some of the plants enumerated may be Eocene, but the Similkameen flora is Lower Miocene or Oligocene. It is closely allied to the Green River and Florissant floras which Lesquereux regards as Oligocene or Upper Eocene." It is further evident, however, that these beds are superimposed in part, perhaps for their entire extent, upon older Tertiary strata which are of Lower Eocene or Fort Union age, and which immediately overlie the Cretaceous strata. These beds undoubtedly extended as far east as Turtle mountain in Manitoba, but eventually the eastern section lying in Manitoba, Saskatchewan, Alberta and the more northern districts of the Mackenzie river, was separated from the western areas by the great uplift of the Rocky mountains which was brought about in Miocene time. Whether there were any Miocene deposits to the eastward of the mountains does not appear from the evidence at hand, but it is a fair presumption that the Oligocene was represented there as it now is farther west. In such case this formation must have been removed by the extensive erosion to which the eastern areas have been subjected, or the beds are yet to be found in the upper portions of those towering buttes which give such striking character to the region; and in the base of which lignite beds are found.

It only remains to present a review of the general evidence upon which the position of the earlier Tertiary beds is recognized as Upper Laramie, Fort Union or Lignite Tertiary.

Referring to the Central Plateau of Saskatchewan and Alberta Dr. G. M. Dawson employs the following description:—

"The steppes of this great slope may be naturally divided into three groups having different ages and circumstances of deposition, and boldly marking three distinct prairie

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[1] Kamloops Map Sheet. Geol. Surv. Can., 1877–78, 112 B.
[2] Trans. R.S.C., VIII, 1890, iv, 90.

levels. To the most recent of these belong the two prairies which surround Lake Winnipeg and the lakes of that group, including the marshy country to the west of Manitoba lake. This forms the first prairie level. In the vicinity of the Red River settlement its composition is of argillaceous marl, with a deficiency of sandy matter, and it is invariably stratified in thin layers. Underlying this at various depths from the surface is a bed of stiff clay, which forms the immediate margin of the river at many places. The upper layers of this deposit contain leaves and fragments of wood and reeds, and the whole is undoubtedly a fresh-water deposit, indicating a time when the Winnipeg group of lakes covered a much more extended area than at present, the gradual deepening of the rocky channels through the eastern axis having increased the drainage in modern times."

He further remarks that the lignites seem to prove the frequent elevation of parts of the area above the surface of the water, and the general prevalence of plant remains in the intervening sands and clays shows that at no time were land surfaces far distant. The palaeontological resemblance of the beds with those of the typical Fort Union is exact. Their lithological similarity, though less to be depended upon, is not less striking; but the rocks of the 49th parallel, when compared with the section of the Missouri river, appear to show a general tendency of the beds, northward, to more carbonaceous matter. The lignites are more generally found, are usually thicker, and almost always more compact and poorer than those of the eastern extension of the Tertiary to the south. The identity of the rocks on the Line, however, from Roche Percee westward to Wood mountain, with the eastern fresh-water extension of the souther Lignite Tertiary, generally known as the Fort Union Tertiary, does not admit of doubt, and to whatever horizon the one is finally adjusted, the other must follow. He also shows that the Mollusca generally resemble those from the Fort Union of Missouri and "fix with certainty the stratigraphical position of the beds."

In showing that from the Souris river westward the Lignite Tertiary nearly always occupies high ground, and frequently forms a well developed plateau resting on Cretaceous clays, the same author expresses little doubt as to the identity of the beds of the 49th parallel with those of the Judith River formation, which the recent studies of Stanton and Hatcher[1] have definitely located in the Montana group, immediately under the Pierre and Fox Hills group, which in turn are overlaid by the Laramie.

Sir William Dawson, upon whose work rests very largely our present knowledge of the Lignite Tertiary flora of Canada and its stratigraphical relations, has shown that the plants of the Porcupine Creek group are, for the most part, identical with those found by American geologists in the Fort Union series, and which have been described by Prof. Newberry and Lesquereux. They are similar to plants collected by Dr. Richardson in the lignite series of the Mackenzie river, as described by Heer. They also approach very closely to the so-called Miocene floras of Alaska and Greenland as described by Heer. While on the one hand there is a strong resemblance of the flora to the Miocene flora of Europe, on the other hand, the association in the lower beds of reptilian remains of a Mesozoic type, and the association of a similar flora with Cretaceous marine animal remains in Dakota and Vancouver suggests a Lower Eocene age.

Our own studies have shown that Dawson's conclusions were essentially correct. From the general evidence presented it thus becomes possible to establish the relations of all the Tertiary beds of western Canada, so far as now studied, and this relation is as follows:—

1 Geology and Palaeontology of the Judith River Beds, U. S. Geol. Surv., Bull. 257, 1905.

UPPER LARAMIE, LOWER EOCENE, FORT UNION OR LIGNITE TERTIARY.

Saskatchewan—

Souris river.
Porcupine creek.
Great valley.
Saskatchewan.

Alberta—

Calgary.
Cochrane.
Red Deer river, mouth of the Blindman river.
Edmonton.

N. W. Territories—

Mackenzie river.

British Columbia—

Burrard inlet.
Omineca river.
Finlay river.
Coal brook.
Blackwater river.

OLIGOCENE, UPPER EOCENE TO LOWER MIOCENE.

Quesnel.
Quilchena.
Horsefly river.
Coal gully.
Similkameen river.
Nine-mile creek.
Kettle river.
Tulameen.
Stump lake.
Tranquille river.
Kamloops.

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MAPS

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